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BIOMETRIKA

A JOURNAL FOR THE STATISTICAL STUDY OF BIOLOGICAL PROBLEMS

FOUNDED BY
W. F. R. WELDON, FRANCIS GALTON AND KARL PEARSON

EDITED
IN CONSULTATION WITH FRANCIS GALTON
AND IN COLLABORATION WITH

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Yrs affectionately

W F R Weldon

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BIOMETRIKA.

WALTER FRANK RAPHAEL WELDON. 1860–1906.*

I. *Apologia.*

It is difficult to express adequately the great loss to science, the terrible blow to biometry, which results from the sudden death during the Easter vacation of the joint founder and co-editor of this journal. The difficulty of adequate expression is the greater, because so much of Weldon's influence and work were of a personal character, which only those who have enjoyed his close friendship can estimate, and which will only to some extent be understood should it ever be possible to publish his scientific correspondence. That correspondence is not only the most complete record of the development of the biometric conceptions, but the amplest witness to Weldon's width of knowledge, keenness of intellectual activity, and intense love of truth. It is marked by an extreme generosity to both friend and foe, which is not in the least incompatible with the use of frankly—perhaps it would be better to say playfully—strong language whenever the writer suspected unfair dealing, self-advertisement, or slipshod reasoning masquerading as science. Any form of publicity was very distasteful to Weldon; in particular he had a strong dislike for all forms of personal biography. The knowledge of this makes the writing of the present notice a peculiarly hard task. Yet Weldon's influence and activity must always be associated with the early history of biometry; if there be anything which can effectively aid younger workers in this field, it must be to realise that at least one man of marked ability and of the keenest scientific enthusiasm has devoted the most fertile years of his life to this new branch of science. Weldon's history is not written in a long series of published memoirs; much of his best work was unfinished at his death, and we can only trust that it will eventually be completed as the truest memorial to his life. But science, no less than theology or philosophy, is the field for personal influence, for the creation of enthusiasm, and for the establishment of ideals of self-discipline and self-development. No man becomes great in science from the mere force of intellect, unguided and unaccompanied by what really amounts to moral force. Behind the intellectual capacity there is the devotion to truth, the deep sympathy with nature, and the determination to sacrifice all minor matters to one great end. What after all helps us is not that "he settled *Hoti's* business"...

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* I have gratefully to acknowledge much aid from Mr A. E. Shipley in the preparation of certain parts of this memoir. K. P.

> "Properly based *Oun*—
> Gave us the doctrine of the enclitic *De*,"

but that the Grammarian had the strength of will which enabled him "not to Live but Know."

If there is to be a constant stream of men, who serve science from love as men in great religious epochs have served the Church, then we must have scientific ideals of character, and these do involve some knowledge of personal life and development. It is the abuse of the personal so prevalent in modern life, the mere satisfaction of a passing curiosity, which we have to condemn. But the personal which enables us to see the force of character behind the merely intellectual, is of value, because it moulds our working ideals. We see the environment—imposed and self-created—which favours scientific development, and we can with accumulating experience balance environment against heritage in the production of the highest type of scientific mind. From the standpoint that no man works effectively without a creed of life, that for width of character and healthy development there must ever be a proper balance of the emotional and the intellectual, it would be a distinct loss if the personal were removed from what we know of the lives of Charles Darwin and James Clerk-Maxwell. Science, like most forms of human activity, is occasionally liable to lose sight of its ultimate ends under a flood of controversy, the strugglings of personal ambition, or the fight for pecuniary rewards or less physical honours. The safety of science lies in the inculcation of high ideals among its younger votaries. A certain amount of purely human hero-worship is not to be condemned, and yet this is impossible without some knowledge of the personal. Weldon himself was no more free from hero-worship than the best of his contemporaries. Of the men whose influence tended most to mould his life and career—F. M. Balfour, T. H. Huxley, Francis Galton—the personal side was not the smaller element. There was enthusiasm, hero-worship in its best sense, unregarding self-sacrifice in the defence of the man who had become for Weldon not only an ideal thinker, but an ideal character. In the defence of hero or friend, Weldon belonged to a past age, he was out with his rapier, before considering the cause; it was enough for him to know that one he loved or admired was attacked. A criticism of Huxley was to the end inadmissible; if at any point apparently correct, this appearance of correctness was due solely to the inadequate manner in which the facts of his life had been reported by biographers,—the class who pandered to the public love of the petty. It was in this spirit that Weldon received with delight the request to write for the *Dictionary of National Biography*, a scientific appreciation of Huxley's work. From Weldon's standpoint that appreciation should have formed the "Life." It is a fine piece of work and it was a labour of love, but those who have ever watched the younger man with the old, will know that the Huxley of the appreciation was not all that

Huxley meant to Weldon; the feeling of affectionate reverence did not spring from intellectual appreciation. It had far more its source in the influence of a strong character on a sympathetic character. And when we turn to Weldon himself, his relation to his friends and pupils was not purely that of a keen strong intellect; his best and greatest influence arose from the strength of character, that subtle combination of force and tenderness, which led from respect for the master, to keenest affection for the man.

If then we are to realise his life, it cannot be by a strict adherence to an appreciation of his published work. Some account of his stock, his early environment, and his temperament becomes needful, and the value of such an account lies in the help with which any life spent in single-eyed devotion to the pursuit of truth provides us, when we have ourselves to form our creed of life, and to grasp that science is something more than one of the many avenues to a competency. It must be in this spirit, therefore, that Weldon's dislike to the biographical is in a certain sense, not forgotten, but frankly disregarded in these pages.

II. *Stock and Boyhood.*

It would be impossible in a journal like *Biometrika*, devoted to the consideration of the effects of inheritance and environment, to pass by the striking resemblance of Raphael Weldon to his father Walter Weldon. The facts of Walter Weldon's life are given in the *Dictionary of National Biography*. It appears to have been a resemblance not only in intellectual bent, but also in many respects in emotional character. Raphael Weldon's paternal grandparents Reuben Weldon and his wife Esther Fowke, belonged to the manufacturing middle class. Their son Walter Weldon was born at Loughborough, October 31, 1832. Of his childhood we know little, he was as reticent as his son about both his childhood and his home surroundings; there is reason to suppose they were not wholly happy, and that shadows from these early years may have cast themselves not only over the father, but in a lesser extent have moulded the thought and life of the son. Walter Weldon married Anne Cotton at Belper, March 14, 1854, and shortly afterwards, leaving his father's business, came to London, starting as a journalist, writing for the *Dial* and *Morning Star*. Here he first made the acquaintance of William and Mary Howitt, who proved long and intimate friends of the family. From 1860 to 1864 he edited Weldon's *Register of Facts and Occurrences relating to Literature, the Sciences and the Arts,* and had as contributors a number of men afterwards well known in the world of letters. Thus while Walter Weldon's real name was to be made in science, his first interests were in literature and art. The steps by which Weldon regenerated the manganese peroxide used in the manufacture of chlorine, and the extensions he made of his chlorine process up to his death have been well described by Dr Ludwig Mond in his address in 1896 to the Chemical Section of the British Association. They brought Weldon comparative wealth, though nothing compared with the three-quarters of a million pounds his process saved this country annually. They also brought him scientific reputation; a vice-presidency of the Chemical Society, and in 1882 the fellowship of the Royal Society. But for our present purposes the main point is this: that Walter Weldon made his discovery while totally unacquainted with the methods of quantitative chemical analysis and possibly because of this ignorance. He was accustomed to attribute the discovery to a peculiar source, but those who knew well the immense facility of his son for closely observing phenomena out of his own field of research, and rapidly studying their interaction, always probing things, whether in the physical universe, or in mechanism, to their basis in simple laws of nature, will at once realise the source of the father's inspiration, and the heritage to the son*.

If Walter Weldon's discovery brought him wealth, he was generous to a fault. Like his son he appears to have scarcely known the value of money, except as a means of giving pleasure to his friends. His early death in September, 1885, two years after his son's marriage, cut off a career far from completed. But his life had been lived to the full, each instant crowded with physical, intellectual, or emotional activity. It is impossible to regard Walter Weldon's character without seeing whence Raphael Weldon drew much of his nature. The intense activity, the keen sympathy and generosity, the reticence, the creative power in many channels, the artistic appreciation†, were common to father and son. Nay, perhaps to give expression to a paradox, their volume of life was too great to be compatible with its normal length. There are men—not the least favoured of the Gods—who live so widely and so deeply, that they cannot live long. Discussions on the inheritance of longevity now come back to the memory, wherein Weldon referred to stocks of short-lived but intense life, and the personal experience and its moulding effect on character are now clear, where at the time the mind of the listener ran solely on a correlation coefficient.

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* Raphael Weldon delighted during his many voyages in spending days in the engine-room; he made a study of the various types of engines, and his knowledge in this respect was not without service to the Marine Biological Association. He even studied the use of indicator diagrams. His first plan with a new bicycle was to take it part from part, so that he could fully understand its working and the nature of possible repairs. The microscope was not merely an instrument to work with, but a familiar illustration of optical laws, so that he knew at once how to modify each detail to suit special needs. Over and over again, talking over physical problems he would say: "Well, I don't know what you people think, but it has always seemed to me that"—and then would come some luminous suggestion or apt criticism of a proposed investigation in a field wholly outside the biological. A striking instance of this occurred only in the autumn of last year. Many friends had already gone to see the eclipse, most people were talking about it, and Weldon was left in sultry Oxford, fighting out a theory of determinantal inheritance. It was settled that a holiday should be taken, the determinants put on one side and a continuous photographic record made of the eclipse. Neither Weldon nor his colleague knew anything about sun-photography, and miserable were their first attempts. But gradually the objective, the telephoto lens and the focal shutter were worked out; a camera which had done yeoman service in photographing snail habitats became a wonderful structure, and a whole series of colour screens prepared from biological sources were tested and criticised. It was Weldon who obtained the first clean cut photograph showing sun spots clearly and admitting of definite enlargement. But what is more, each developmental stage of his sun camera had been thought out physically, and he knew why he took it. The trained physical astronomer would have found the stages already made, and *a posteriori* each would have been obvious, but this was the case of a biologist with insight into other fields and a striking power of making things work.

† An interesting illustration of the relationship is given in *Mary Howitt, an Autobiography*, 1889 (p. 184). The child Raphael, then 10 years, had gone with his father and the Howitts to visit the Wiertz Gallery at Brussels. William Howitt writes: "On our first entrance I was quite startled, I did not think I should at all like the paintings, they appeared so huge, so wild and so fantastic. But by degrees I began to see a great mind and purpose in them……. Little Raphael came and took my hand as we left the gallery, and said: 'Mr Howitt, I think Wiertz could not be a good man.' I asked him why. He answered, 'I think he could not be a good man, or he would not have painted some things there.' I told him he might naturally think so, but that a vast deal was to be allowed for his education. No doubt Wiertz thought all was right, and that many of his pictures contained

In one respect Raphael Weldon differed widely from his father. Walter Weldon turned naturally to the mystical to satisfy his spiritual cravings; he was a Swedenborgian, and *ipso facto* a believer in intercourse with another world. Whether owing to a difference of training or of temperament, these things were to Raphael Weldon uncongenial. He was through the many years the present writer knew him, like his hero Huxley, a confirmed Agnostic. Sympathetic as every cultured mind must be with the great creations of religious faith; knowing more than many men of religious art—painting, sculpture, and music—he yet fully realised that these things had for him only emotional, no longer intellectual value*. It may be that the difference of training made this distinction between father and son, for the latter's mind was keenly alive to spiritual influences. A solitary fortnight with the beloved Dante was not solely pleasure; the re-perusal of the *Inferno* left its sombre influence on Weldon's thoughts for long after, testifying not only to its author's supremacy, but to the spiritual impressibility of the reader's nature.

It may be that the difference was due to heritage from the mother's side. Of Anne Cotton we know little, she died in 1881, when Raphael Weldon had just taken his degree. She appears to have exercised a rather stern discipline, which had greater influence on Raphael, than on his brother Dante. She was a devoted companion to Walter Weldon, and a resourceful helpmate in his early struggling days†. A daughter Clara born in 1855 died in 1861. Of his childhood Weldon rarely spoke. He was born in the Highgate district, and shortly after his birth his parents removed to a three-gabled house on the West Hill still standing. Here we get occasional peeps of a solitary child who would retire for hours under the dining-room table with his Shakespere, learning whole acts by heart. At six years old he appears in Mary Howitt's letters as staying at Claygate near Esher.

great and useful lessons. His father came up and added that when Raphael was older he would see those lessons more clearly than he could now."

The prophecy was fulfilled, in perhaps rather a different way. The little Raphael became a big Raphael who did not look to art "for great and useful lessons," and who refused to study Ibsen because undiscerning critics made current the idea that his art was subservient to inculcating a lesson.

* The "fulness of life" admitted, nay demanded, many a visit to cathedral service, especially in Italy. Even a study of Gregorian music was entered upon, and the writer recollects many a summer's afternoon spent in visiting the churches of Oxfordshire and Berkshire,—the cycle ride, the keen eye on surrounding nature, not only from the standpoint of the biologist, but of the artist; then the break to the religious past, the "biometric tea" at the village inn; the return journey towards evening and the discussion which touched many things, from *Draba verna* to the Norsemen in Sicily. The "volume of life" was there, as it was in the midnight talks in Wimpole Street or in the discussions in the study at Merton Lea.

† See *R. S. Proc.* Vol. XLVI. "Obituary Notice of Walter Weldon," p. XIX. *et seq.*

"We find little Raphael Weldon one of the best of children. Secker is mowing the grass at this moment, and he harnessed like a pony is drawing the machine. The Pater calls him 'Young Meritorious.'" And again:

"[Agnes] and Raphael are the best of friends, and their ringing laughter comes to us in the garden through the open window, as they sit in the dining-room painting the Stars and Stripes and the Union Jack for each other's amusement.... Agnes is a little free-spoken American full of fun and *dash*. Raphael more silent and contemplative. They sit painting pictures together for hours at a time. I feel quite proud of them both."*

In 1870 comes the flying visit to Brussels; in 1872 a still more memorable first visit to Paris, where the destruction caused by the Commune to the Tuileries and other buildings much impressed the boy. The Weldons had moved meanwhile to The Cedars, Putney, and shortly afterwards went to the Abbey Lodge, Merton, near Wimbledon. The visits and the changes give one the impression of a rather broken education. We have no record of what school Raphael Weldon attended, if any, at Highgate. At Putney he had as tutor a neighbouring clergyman. In 1873 he was sent to a boarding-school at Caversham, and from this time onwards the educational career is more definite.

Even before 1870, however, we find in the boy the father of the man. His great pleasure was to organise lectures for his children friends, and the adult population, if it could be procured. The seats were formally arranged, tickets provided, and the boy would discourse on slug or beetle procured in the garden, observation and the scanty literature available providing the material. According to a surviving auditor the lectures were carefully prepared and good so far as they extended.

Of the school at Caversham we have some detailed information. Mr W. Watson, its headmaster, had been a private 'coach' in London to University College students. In 1865 he opened a school at Reading, which was transferred to the hill out of Caversham in 1873†. Mr Watson's daughter Ellen Watson had a brief but brilliant career as a mathematician and pupil of W. K. Clifford's. Her life has been written by Miss Buckland. It is possible that she first stirred Weldon's mathematical tastes, as he spoke with admiration of her powers; she does not, however, appear to have taught in the school. The pupils were chiefly sons of Nonconformists of some eminence. Among the earlier scholars were Viriamu Jones, Alfred Martin, and E. B. Poulton, and among the later pupils Owen Seaman, F. W. Andrewes, P. Jacomb-Hood, and W. F. R. Weldon; names afterwards distinguished in literature, science, or art. The headmaster appears to have been a clever man of wide knowledge and sympathy, but there was little to specially encourage biological tastes in the school. It is reported of one under-

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* *Loc. cit.* p. 162 *et seq.*

† As an illustration of Weldon's reticence I may state that we had passed this house several times together, before he mentioned it as his old school.

Raphael Weldon aged 10.

master that he protested against the study of insects, asking: "How do you think that such pursuits will put a leg of mutton on your table?" and the ability that proceeded from the school has been attributed by one of its former pupils to the special class from which it drew its chief material.

III. *Lehrjahre.*

Weldon did not remain fully three years at this school. It was followed by some months of private study and he matriculated at 16 (1876) in the University of London. In October of '76 we find him at University College taking classes in Greek, English, Latin, and French, with two courses of pure mathematics. In the summer term of 1877 physics and applied mechanics were studied. During this whole session he also attended Daniel Oliver's general lectures on botany and Ray Lankester's on zoology. He used to come up to town for Oliver's 8 o'clock lectures, getting his breakfast at a bun-house on the way*. Of his education at University College he especially praised in after years Olaus Henrici's lectures on mathematics. They were he held most excellent, and he considered Henrici the first born teacher under whom he came. Later in the Christmas vacation of 1879, after he had gone up to Cambridge, he researched for some weeks under Ray Lankester, who set him to work out the structure of the gills of the mollusc *Trigonia*. This completes Weldon's relations as a student to University College.

The difficulty of access, or possibly Walter Weldon's strong views, led Raphael Weldon in the autumn of 1877 to transfer himself to King's College. Here he stayed for two terms attending classes in chemistry, mathematics, physics, and mechanics, beside the zoology course of A. H. Garrod and the biology of G. F. Yeo. Divinity under Barry, at that time I believe compulsory, was also taken. At this time Weldon had the medical profession in view. He was only entered on the Register of Medical Students on July 6, 1878, but there can be no question that his course on the whole was directed towards the Preliminary Scientific Examination of the London M.B. This examination he took in December, 1878, after he had gone up to Cambridge; he was coached for it by T. W. Bridge, now Professor of Zoology in Birmingham, but he had already completed the bulk of the work in his London courses. With the Preliminary Scientific, Weldon's relation to London ceased. His student career there was not of quite two years' duration and it dealt with a variety of subjects, dictated as much by Weldon's catholic tastes, as by the discursiveness of the London examination schedule. But in his case, as in that of others, the grounding he received in physics and mathematics became a valuable asset, and the taste for languages, afterwards so emphasised, was to some extent trained and coordinated with literary knowledge. Yet Weldon's earlier instinct to study biology was not substantially modified either by the choice of medicine as a profession or by the diversity of his London studies. In 1877 he attended the Plymouth Meeting of the British Association, and there he was generally to be found in Section D.

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* Weldon states in his applications for the Jodrell and the Linacre Chairs that he commenced the study of zoology under Lankester in 1877.

The presence of a life-long friend, who had already gone to Cambridge, was at least one of the causes which led to Weldon's entering himself as a bye-term student at Cambridge, and probably his choice of St John's College was due to Garrod's influence. He was admitted on April 6, 1878, as a pupil of S. Parkinson's. In the record his father is given as a "Journalist," although the chlorine process had now become a success, and his reference is to the Professor of Mathematics at King's College, then W. H. Drew*.

At Cambridge Weldon soon found his work more specialised and he rapidly came under new and marked influences. His first May term and Christmas term were devoted to his preparation for Little-Go and the London Preliminary Scientific. For the classical part of the former he seems to have worked by himself. After these examinations were over reading for the Tripos was begun and, under the influence of Balfour, Weldon's thoughts turned more and more to zoology, and the medical profession became less and less attractive. During the years 1879 and 1880 Weldon worked steadily for his Tripos; in the first year he was given an exhibition at St John's, and almost the only break in his work was the York Meeting of the British Association. In the second year a little original investigation on beetles was started; in May he took, for a month, Adam Sedgwick's place and demonstrated for Balfour. Overwork led to a serious breakdown, and resulted in insomnia and other ills, which occasionally troubled him again in later life. At the annual British Association holiday, this year in Swansea, Weldon saw for the first time Francis Galton, but an actual friendship was not begun till some years later.

The Tripos work was continued in spite of ill-health, till the Easter of 1881, when Weldon was unable to enter for the college scholarship examinations. By the influence of Francis Balfour, however, Weldon's real ability was recognised and a scholarship was awarded to him. A three months' holiday had become necessary, and Weldon went to the south of France, returning only shortly before his Tripos examination. At the very start of this, in itself all-sufficient, mental strain, Dante Weldon, who had joined Peterhouse, died suddenly of apoplexy. It says much for Weldon's self-control that the terrible shock of his brother's death, though it greatly affected him, did not interfere with his place in the first class of the Natural Sciences Tripos. The distress he had felt at his brother's death was redoubled a few weeks later when his mother passed away. She had never recovered from the blow resulting from the tragic death of her younger son. Of these things Weldon did not speak, but they undoubtedly influenced immensely his deeply emotional nature. Balfour's untimely death in the following year, and the early death of Weldon's father a few years later, left also their indelible impresses, a certain tinge of melancholy, a doubt whether he too would live to finish his work, and a tendency to take the joy and fulness of life while it was there. Few who saw the almost boyish delight in work and in play, the energy which spent itself for hours at a problem, or cycled eighty or a hundred miles in the day, the activity in debate, the vigour in lecture, the flow of thought and talk to the midnight hours, realised that the man was not of iron physique, and had indeed but small reserves of strength. To see Weldon keen over a piece of work was to believe him robust and ready for any fray; but looking back on the past one can see what each piece of work cost him, and the strain on a highly nervous temperament began in even those early Cambridge days.

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* There are errors in the entries in the Register, Weldon's mother's maiden name is erroneously given as Chester, not Cotton. Weldon was actually born at Suffolk Villa, Highgate.

IV. *Wanderjahre.*

With the Tripos Weldon's *Lehrjahre* closed and, as his nature directed, the *Wanderjahre* began without any interval of rest. Immediately after his Tripos, Weldon started for Naples to work at the Zoological Station. We have seen that at Cambridge he had been a pupil of F. M. Balfour's, whose death from an Alpine accident in the July of 1882 was the greatest loss British zoology had sustained for years. The charm of Balfour's personality had aroused the affection of all who attended his classes, and had awakened a keen desire to follow, even if but a long way behind, in his footsteps. In those days the stimulus given by Darwin's writings to morphological and embryological researches was still the dominating factor amongst zoologists, and Weldon threw himself at first with ardour into the effort to advance our knowledge by morphological methods. In Naples he began his first published work, a "Note on the early Development of *Lacerta muralis*" (1), but at the same time did much miscellaneous work on marine organisms. The lizard paper was finished in the winter at Cambridge, Weldon gratefully acknowledging the help of Adam Sedgwick, in whose laboratory he was then working. Anticipation in the publication of some of the results by C. K. Hoffmann, who had been working at the same points, caused a not unnatural disappointment.

In September Weldon was back in England at the Southampton meeting of the British Association. Here Adam Sedgwick, who had succeeded to the teaching work of Francis Balfour, invited Weldon to demonstrate for him. Thus the winter found Weldon in Cambridge again, and from Sedgwick's laboratory was issued the next piece of work: "On the Head-Kidney of *Bdellostoma*, with a suggestion as to the Origin of the Suprarenal Bodies" (2). Weldon hoped to show that "at all events in Reptiles and Mammals, the connection between the Wolffian body and the suprarenal is much more intimate than has generally been supposed," and he followed the matter up in the next year by publishing his paper "On the Suprarenal Bodies of Vertebrates" (3).

Meanwhile a great change had come over Weldon's personal life. On March 14, 1883, the anniversary of his parents' wedding-day, he was married to Miss Florence Tebb, the eldest daughter of William Tebb, now of Rede Hall, Burstow, Surrey, which formerly, after he left Merton, had been the house of Walter Weldon. The Weldons and Tebbs had been intimate friends for many years, and Miss Tebb had been at Girton while Raphael Weldon was at St John's. At Cambridge the new Statutes had just come into force, marriage was the order of the day, and houses were even difficult to procure. The Weldons on their return from a tour in France took Henry Fawcett's furnished house and settled down in Cambridge for the May term. Raphael Weldon still had his scholarship, and he was demonstrating for Sedgwick. He was now compelled to undertake "coaching,"—work which he gave up as soon as his means would allow of it, for his whole heart was then as afterwards in research. Still this coaching work brought him in touch with many men who afterwards distinguished themselves in biological or other fields.

After the death, on the 14th January, 1883, of Forbes, a fellow Johnian, Weldon for four months—June 15 to October 15—acted as *locum tenens* for the Prosector at the Zoological Gardens, London, and during that time he read the following papers before the Zoological Society: "On some points in the Anatomy of *Phoenicopterus* and its Allies" (4); a "Note on the Placentation of *Tetraceros quadricornis*" (5), and "Notes on *Callithrix gigot*" (6). Weldon did not succeed Forbes—it was rumoured that some of the electors doubted the fitness of his physique for the work and considered that the post was not without danger. But the temporary work into which he threw his usual energy gave him increased insight into vertebrate anatomy and had the further advantage of making him personally known to the active workers in zoology of the metropolis.

In the following year (1884) the paper above referred to on the development of the suprarenal bodies was published in the *R. S. Proceedings.* Weldon was now demonstrating in comparative anatomy at Cambridge, and the holidays were devoted to collection. At Easter Banyuls was visited, and the summer vacation found Weldon in Naples again for three months preparing his fellowship dissertation. In Naples the cholera had broken out, and the Weldons experienced not only difficulty in getting the precious dissertation back to England, but in returning themselves. This was done by an Orient liner, the last allowed to call. Thus began the long series of holidays in Italy with the sea passage to or fro. The summer heat of Naples seemed to suit Weldon, and he could work and think under circumstances which only allow mere existence to an ordinary Englishman. On returning to Cambridge, Weldon was elected to a fellowship at St John's College on November 3rd, and was shortly afterwards appointed University Lecturer in Invertebrate Morphology. About this time the Weldons took a permanent home at No. 14, Brookside, which soon became a centre for Cambridge workers in biology*. The Weldons' home, whether in Cambridge, London, or Oxford, was always a centre, where not only the right people met, but whence actual profit came by the right people interchanging ideas and planning work.

On his return to Cambridge in November 1884 Weldon had taken up again his invertebrate work. His next memoir "On *Dinophilus gigas*" (7) dealt with the anatomy and affinities of *Dinophilus,* at that time a very little known Annelid. A. E. Shipley had been fortunate enough to collect a number of these minute worms at Mounts Bay, Penzance, and had handed them over to Weldon for description. The latter gave a full account of their anatomy and added a careful discussion on the affinities of the genus, expressing his belief that while it is "related on the one hand to *Archiannelida*, it retains on the other many features characteristic of the ancestor common to those groups (especially Chaetopods, Gephyreans, Mollusca, Rotifers and Crustacea) which possess a more or less modified trochosphere larva."

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* "The house in Brookside in which he lived after his marriage until he left Cambridge was a delightful and hospitable centre, where all sorts of subjects were discussed, attacked and defended until all sorts of hours in the morning." A. E. S.

The next few years of Weldon's life were—if it be possible to make any comparative where all were intense—more active than ever. He had now given up coaching, and as he only needed to be in Cambridge two terms of the year, travel and research could occupy the time from the beginning of June to January. On May 8, 1885, Weldon gave his first Friday evening lecture at the Royal Institution on "Adaptation to surroundings as a factor in Animal Development." No report is published in the *Proceedings* of this lecture, but there are those who still remember the impression caused by the youthful lecturer of 25 years of age. And here may be a fitting place to say something of Weldon's lecturing power. There are two distinct sides to lecture work; the instruction of small or large classes of students and the public oration. Success in the one field does not necessarily connote success in the other. In the former case the eye must be kept on the average student, the lecturer must realise what the individual auditor is feeling, he must expand his exposition or must contract it to meet the carefully observed needs of his audience, for he knows that he can take up the subject again on the next occasion exactly where he has left off. In this form of lecturing Weldon was an adept, it brought out all his force and enthusiasm as a teacher. As a writer in the *Times* (April 18, 1906), says:

"Seldom is it given to a man to teach as Weldon taught. He lectured almost as one inspired. His extreme earnestness was only equalled by his lucidity. He awoke enthusiasm even in the dullest, and he had the divine gift of compelling interest."

In public lecturing on the other hand, with a time limit and an unknown audience, the personal touch with individuals is impossible. There is no time to elaborate points, the whole matter must be *a priori* fitted to the time, and if the audience is not grasping an idea, then the lecturer must put both explanation and disappointment on one side; he must make his audience jump gladly, and trust to better luck in his exposition of the next stage of his thesis. Shortly, he must feel his audience with him *as a whole* and pay no regard to the individual.

Weldon's own intense thoroughness made him only too conscious when a portion of his audience were not following him; his highly nervous temperament made it a necessity that he should have a sympathetic grip on the individual. This made for success in his lectures to students; but it brought also a factor of uncertainty into his public lectures. The most carefully prepared discourse, and no man gave more time and energy than Weldon to preparation*, might be spoiled by Weldon's consciousness that certain members of the audience were not following him. He would then turn his exposition into explanation of minor points, so that the lecture would not be completed, or he would settle down to speak to the few he realised to be following him, and neglect the audience as a whole. If a portion of his audience were hostile or actively unsympathetic, this always prevented Weldon from reaching his best; it formed a strain on the lecturer's nervous temperament, which could only be realised by those of like fibre, and in some cases left its permanent mark. Thus it came about that the success of a public lecture by Weldon could not *a priori* be measured; it depended far too much on the audience. Individual lectures at the British Association, the London Institution, at University College or elsewhere were brilliant achievements, but at the same places on other occasions, Weldon was not so successful, for no man was ever more responsive to immediate environment than he was. To do his best and to be at his best he needed essentially a sympathetic environment. Weldon has been spoken of as an eager, ready and dramatic debater, keen to see a weak joint in his opponent's armour and quick in putting his own case with telling effectiveness. This is undoubtedly true, but it needs the qualification that this intellectual readiness when in full action meant a high pressure; it was a strain the less oft repeated the better. A torpedo-boat destroyer is associated with a 26 knot speed, and such speed differentiates it from other vessels of war; but the less it is run at this rate, the longer undoubtedly it will last. Controversy was not an atmosphere in which Weldon rejoiced*; it came to him because he felt bound to criticise what he held to be error, because he must defend a friend, but it was—running the destroyer at 26 knots!

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* Drafts and re-drafts were written, elaborate diagrams painted, or lantern slides made and coloured by Weldon himself.

This digression may be justified on the ground that we have reached the period when Weldon began to exercise a personal influence over his students at Cambridge, and the sources of that influence are to be found first in the lecture-room and then in strong personal sympathy. In the lecture-room he always impressed his hearers with the importance of his topic. You could not listen to him lecturing on a flame-cell or on the variations in the carapace of *Pandalus annulicornis* without sharing his intense conviction of the importance of the matter in hand. He aroused a consciousness in his students that things were worth studying for their own sake, apart from their examination value.

The summer months of 1885 were spent in Guernsey, and the death of Walter Weldon in the September of this year kept Raphael Weldon at other things than research. Christmas, however, found the Weldons at Rome. The Lent and May terms (1886) were spent in Cambridge as usual. In June came a visit to the south of France on Chlorine business, but in July came freedom, the crossing to America and the visit to the Bahamas in August to collect. From his headquarters in the Bahamas Weldon went with two friends to North Bimini in the Gulf stream and enjoyed immensely his first experience of tropical or at least semi-tropical seas. He made considerable collections, but his published results were confined to "*Haplodiscus piger*; a new Pelagic organism from the Bahamas" (8), and a "Preliminary Note on a *Balanoglossus* Larva from the Bahamas" (9). Haplodiscus was netted near the Island of New Providence. It is a member of the Acoela, the most simplified of the class Turbellaria, and for some time Weldon's account was one of the most complete we had of any member of this group. Working at the *Balanoglossus* material in 1887, Weldon found that his results differed from those reached by Professor Sprengel. He accordingly went to Giessen at Easter,—his second visit to Germany, the first having been at Christmas, 1886—and finally handed over to Professor Sprengel the whole of the *Balanoglossus* material he had collected in the Bahamas. During the Lent and May terms Weldon came up from Cambridge and gave a course on Economic Entomology to the forestry students at the Royal Engineering College, Cooper's Hill. The summer and autumn of this year involved a meeting of the British Association at Manchester, a visit on Chlorine business to France, and later, collecting and working in Guernsey. The Christmas was spent at Plymouth.

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* Actual experimental work which upset another man's views, Weldon declined to publish. "Yes, I know he is wrong, but I don't want merely to controvert him, I want to get at the truth of these things for myself." And when he had satisfied himself he would pass on to a new point of investigation and never publish at all.

In 1888 the buildings of the Marine Biological Laboratory in Plymouth were nearly completed, and the visits to Plymouth now replaced those to Guernsey. To the Marine Biological Association Weldon gave both time and sympathy during the rest of his life. His annual visits of inspection to Lowestoft during the last few years were always a great pleasure to him, and he was preparing for and talking of this year's visit only a few days before his death. Lent and May terms, 1888, were spent as usual in Cambridge, but June to December were given up to Plymouth, with a brief Christmas holiday in Munich. And here we must note the beginning of a new phase in Weldon's ideas. His thoughts were distinctly turning from morphology to problems in variation and correlation. He has left on record the nature of the problems he was proposing to himself at this time and they are summed up as follows:

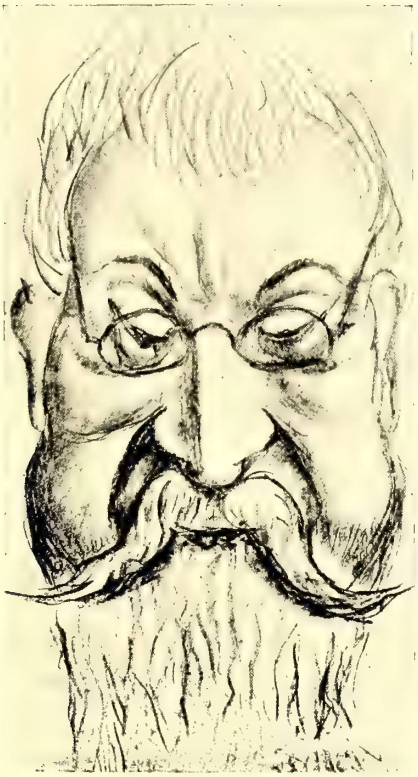
(1) The establishment of a new set of adult characters leading to the evolution of a new family has always been accompanied by the evolution of a new set of larval characters leading to the formation of a larval type peculiar to the newly established family; the two sets of characters having as yet no demonstrable connection one with the other.

(2) The evolution of the adult and that of the larval characters peculiar to a group advance *pari passu* one with the other, so that a given degree of specialisation of adult characters on the part of a given species implies the possession of a larva having a corresponding degree of specialisation and *vice versa*.

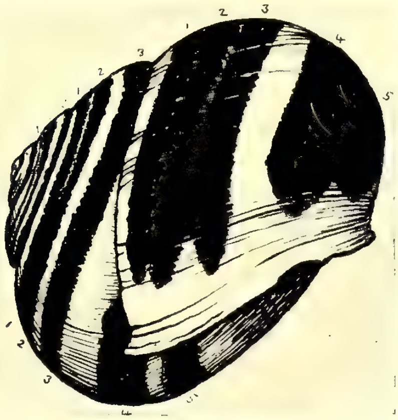
The next year was to place in Weldon's hands a book—Francis Galton's *Natural Inheritance*, by which one avenue to the solution of such problems, one quantitative method of attacking organic correlation, was opened out to Weldon;

and from this book as source spring two of the friendships and the whole of the biometric movement, which so changed the course of his life and work. In 1889, the year of the issue of this book, another change also came. Weldon found that his dredging and collecting work separated him from his books for half his time. Accordingly, he applied for a year's leave from Cambridge, and the Weldons settled down in a house of their own at Plymouth. This period of hard work lasted through 1890, and was broken only by flying visits to Dresden in September and at Christmas, 1889, and an autumn visit in 1890 to Chartres and Bourges. The intellectual development and the experience and knowledge gained in this period were far more important than the mere published work would indicate. In 1889, Weldon investigated the nature of the curious enlargement of the bladder associated with the green, or excretory, glands in certain Decapod Crustacea, and published in October of the same year his paper on "The Coelom and Nephridia of *Palaemon servatus*" (10). The result of his investigation was to confirm "the comparison so often made (by Claus, Grobben, and others) between the glomerulus of the vertebrate kidney and the end-sac of the Crustacean green gland." A little later, June 1891, Weldon published the results of more extended researches in this field in what proved to be his last strictly morphological paper. It was entitled: "The Renal Organs of certain Decapod Crustacea" (11). In this he showed that in many Decapods spacious nephro-peritoneal sacs "should be regarded rather as enlarged portions of the tubular system...than as persistent remnants of a 'coelomic' body cavity into which the tubular nephridia open."

One further paper of a year later may be best referred to here, Weldon's only piece of work on invertebrate embryology, "The Formation of the Germ Layers in *Crangon vulgaris*" (12). This contains a clear account of the early stages of segmentation and the building up of the layers of the shrimp, illustrated by excellent figures. And here it may be mentioned that Weldon's power with the pencil was not that of the mere draughtsman, accurate in detail, but too often lifeless. Weldon was an artist by instinct, and he had the keenest pleasure in drawing for its own sake. His brilliant blackboard drawings will be remembered by all his students; some correspondents will remember elaborately beautiful sketches sent merely to illustrate a passing question, where a rough diagram would have sufficed; a delicately pencilled shell to please a child friend; carefully copied architectural details to gratify himself and made to be destroyed;—all signs of a real artistic power of creation. And the sense he enjoyed in himself, he appreciated in others. Nothing refreshed him so much as a visit to the National Gallery, or to a lesser extent the sight of more modern art. Weldon, smiling before one of his own pictures, unconscious of his environment, was good to behold, and made one realise how for him pictures were still differentiated from furniture. In the last two years of his life, when he had become an ardent photographer, the artistic feeling came to play a prominent part as the difficulties of the craft were one by one mastered.



(*a*) "L'Apparition: Le Café Orleans."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(*b*) H. Hortensis, from a letter.

December, 1890, closed the Cambridge work* and concluded the *Wanderjahre.* Weldon now succeeded Ray Lankester in the Jodrell Professorship at University College. In June he had been elected a Fellow of the Royal Society largely on the basis of his first two biometric papers, which will be considered more in detail in the next section.

It will be seen that the years between Weldon's degree and his first professoriate were years of intense activity. He was teaching many things, studying many things, planning many things. His travels perfected his linguistic powers, and his fluency in French, Italian and German was soon remarkable. But while this added immensely to his delight in travel, it opened to him also those stores of literature, which appealed so strongly to his artistic temperament. From the mediaeval epics to Balzac he was equally at home in French literature; and the Italian historians were read and carefully abstracted, that he might understand Dante without the aid of a commentator, and appreciate Italian towns without the help of a guide-book. In German he had a less wide knowledge of the earlier literature and history, but he spoke the language with an accent and correctness remarkable in an Englishman. In later years he had commenced the study of Spanish, the Romance tongues and literatures being always more sympathetic to him than the Scandinavian or Teutonic. His remarkable thoroughness in science reappeared as a form of scholarly instinct when he approached history and literature, and the present writer remembers Weldon's keen pleasure and exactitude in following up more than one historical enquiry. His delight in knowing spread far beyond the limits of natural science.

V. *London and the First Professoriate,* 1891–1899.

A word must here be said as to the transition which took place during the *Wanderjahre* in Weldon's ideas. He had started, as most of the younger men of that day, with an intense enthusiasm for the Darwinian theory of evolution; it threw open to him, as to them, a wholly new view of life with its possibility of seeing things as a connected whole. Weldon realised to the full that the great scheme of Darwin was only a working hypothesis, and that it was left to his disciples to complete the proofs, of which the master had only sketched the outline. Naturally he turned first to those methods of proof, morphological and embryological, which were being pursued by the biological leaders of the period, and it was only with time that he came to the conclusion that no great progress could be attained by the old methods. We have already seen that even before the appearance of *Natural Inheritance,* Weldon's thoughts were turning on the distribution of variations and the correlation of organic characters. He was being led in the direction of statistical inquiry. The full expression of his ideas is well given in the first part of the "Editorial" with which *Biometrika** started :

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* A note may be added as to the general influence of Weldon at Cambridge. At the time Weldon began lecturing there were a considerable number of students largely attracted to Cambridge by Balfour's fame and remaining there to mourn his loss. Mr W. Bateson of St John's, Dr Harmer of King's, Professor Sherrington of Caius, Professors D'Arcy Thompson and J. Reynolds Green of Trinity, Professor Adami and Mr A. E. Shipley of Christ's, graduated in 1883 and 1884, and all, to some extent, came under his influence. For six years (1884–1890) he gave advanced lectures to the candidates for Part II of the Natural Sciences Tripos. During these few years the number of men in his class who have since done much to advance science was considerable. The following is by no means a complete list. Among botanists, F. W. Oliver, C. A. Barber, W. B. Bottomley; among geologists, T. T. Groom, P. Lake, S. H. Reynolds, H. Kynaston and H. Woods; among physiologists, pathologists and medical men, A. E. Durham, H. E. Durham, J. S. Edkins, W. B. Hardy, A. P. Beddard, E. H. Hankin, H. Head; and among zoologists, H. Bury, G. P. Bidder, W. F. H. Blandford, R. Assheton, F. V. Theobald, T. H. Riches, E. W. MacBride, H. H. Brindley, A. T. Masterman, C. Warburton, and Malcolm Laurie.

> "The starting point of Darwin's theory of evolution is precisely the existence of those differences between individual members of a race or species which morphologists for the most part rightly neglect. The first condition necessary, in order that any process of Natural Selection may begin among a race, or species, is the existence of differences among its members; and the first step in an enquiry into the possible effect of a selective process upon any character of a race must be an estimate of the frequency with which individuals, exhibiting any degree of abnormality with respect to that character, occur. The unit, with which such an enquiry must deal, is not an individual but a race, or a statistically representative sample of a race; and the result must take the form of a numerical statement, showing the relative frequency with which various kinds of individuals composing the race occur."

It was Francis Galton's *Natural Inheritance* that first indicated to Weldon the manner in which the frequency of deviations from the type could be measured. A mere catalogue of exceptional deviations seemed to him of little value for the study of Natural Selection. But this description of frequency was only the first stage. How did selection leave the distribution? and How was the intensity of selection to be measured? naturally arose as the next problems. These problems led at once to the even greater question of the influence of selection on correlation. What is the relation between organs in the same individual, and how is this changed, if at all, by the differentiation of species, or at least by the establishment of local races? Nor could the problem of evolution be complete without ascertaining the manner in which deviations were inherited. The modern biometric methods of discussing these problems, if very far from fully developed, were at least suggested in Galton's great work, and that book came as a revelation not only to Weldon, but to others who were preparing to work on similar lines†.

In Plymouth, 1890, Weldon started his elaborate measurements on the Decapod Crustacea and soon succeeded in showing that the distribution of variations was closely like that which Quetelet and Galton had found in the case of man. So far as the present author is aware, the paper "The Variations occurring in certain Decapod Crustacea I. *Crangon vulgaris*" (13) was the first to apply the methods of Galton to other zoological types than man‡. In this paper Weldon shows that different measurements made on several local races of shrimps give frequency distributions closely following the normal or Gaussian law. In his next paper,

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* Vol. I. p. 1.

† The present writer's first lecture on inheritance was given on March 11, 1889, and consisted of an exposition and amplification of Galton's theory.

‡ Galton had dealt with the weights of sweet pea seeds, Merrifield with the sizes of moths, but they had not published fitted frequency distributions.

"On certain correlated Variations in *Crangon vulgaris*" (14), Weldon calculated the first coefficients of organic correlation, i.e. the numerical measures of the degree of interrelation between two organs or characters in the same individual. It is quite true that the complete modern methods were not adopted in either of these papers, but we have for the first time organic correlation coefficients—although not yet called by that name—tabled for four local races. These two papers are epoch-making in the history of the science, afterwards called biometry.

It is right to state that Weldon's mathematical knowledge at this period was far more limited than it afterwards became. The first paper was sent to Francis Galton as referee, and was the commencement of a life-long friendship between the two men. With Galton's aid the statistical treatment was remodelled, and considerable modifications made in the conclusions. But the credit of making the vast system of measurements, of carrying out the necessary calculations (now with the aid of his wife, who was for years to assist in this part of the work), of seeing *a priori* the bearing of his results on the great problems of evolution, must be given to Weldon. Nor must we forget the rich suggestiveness of these papers. Weldon was on the look-out for a numerical measure of species. He was seeking for something constant for all local races, and although his suggestion that the correlation coefficient was a constant for local races has not been substantiated—the "selection constant," the quantity uninfluenced by racial differentiation, being of a much more complex nature—yet his suggestion directly led up to the investigation of correlation in man, animals and plants, and has given us immensely clearer ideas on the inter-relationship of organic characters. And Weldon realised this also:

> "A large series of such specific constants would give an altogether new kind of knowledge of the physiological connexion between the various organs of animals; while a study of those relations which remain constant through large groups of species would give an idea, attainable in no other way, of the functional correlations between various organs which have led to the establishment of the great sub-divisions of the animal kingdom*."

The defect in mathematical grasp, which Weldon had realised in his first paper, led him at once to seek to eliminate it. He sought first to 'enthuse' a mathematician with his project of demonstrating Darwinian evolution by statistical enquiries. A visit was paid to Cambridge with this end in view, but it did not lead to the required result. Weldon then set about increasing his mathematical knowledge by a thorough study of the great French writers on the calculus of probability. He did not turn to elementary text-books but with his characteristic thoroughness went to the fountain head. Turning over his papers now, it is astonishing to notice the completeness of his studies as evidenced by his notes and abstracts. He thus attained to a very great power of following mathematical reasoning and this power developed with the years. He never reached a high wrangler's readiness in applying analysis to the solution of new questions, possibly this requires years of training in problem papers; but he was able to follow and criticise extremely complicated algebraical investigations, and to reproduce and often simplify them for the use of his own students. He had, however, a touch with observation and experiment rare in mathematicians. In problems of probability he would start experimentally and often reach results of great complexity by induction. Thus he was able to find out a number of problems relating to the correlation between a throw of *n* dice, and the result obtained when a re-throw of *m* out of the number *n* was made, and others relating to the mixture of *n* packs of cards and the throwing out of random portions*. In all these cases Weldon was illustrating by a game of chance a definite biological process.

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* *R. S. Proc.* Vol. LI. p. 11.

From 1890 onwards, Weldon's knowledge, theoretical and experimental, of the theory of chance increased by bounds. Weldon and the present writer both lectured from 1 to 2, and the lunch table, between 12 and 1, was the scene of many a friendly battle, the time when problems were suggested, solutions brought, and even worked out on the back of the *menu* or by aid of pellets of bread. Weldon, always luminous, full of suggestions, teeming with vigour and apparent health, gave such an impression to the onlookers of the urgency and importance of his topic that he was rarely, if ever, reprimanded for talking 'shop.'

It is difficult now, after fifteen years of common work and continuous interchange of ideas, to distinguish where one or other idea had its source, but of this the writer feels sure, that his earliest contributions to biometry were the direct results of Weldon's suggestions and would never have been carried out without his inspiration and enthusiasm. Both were drawn independently by Galton's *Natural Inheritance* to these problems, but the papers on variation and correlation in shrimps—which in rough outline are types of all later biometry—were published before their friendship had begun.

Weldon's work at University College commenced in 1891. The house in Wimpole Street was taken and, if possible, life became more intense. Easter was spent at Chartres. In the summer came the annual visit to Plymouth, where work on crabs was now to replace that on shrimps. September gave some rest with a sea trip to Malta. In October came the college inaugural lecture for the session, Weldon taking as his subject the statistical treatment of variation. At Christmas there was a break for opera in Munich and Dresden. This year and the next were strenuous years in calculating. The Brunsviga was yet unknown to the youthful biometric school; the card system of correlating variables was still undeveloped, we trusted for multiplication to logarithms and Crelle, and computors trained to biometric work had to be created. The Weldons toiled away at masses of figures, doing all in duplicate. At Easter, 1892, they went to Malta and Naples, and the summer was spent over crab-measurements at the zoological station in the latter city, and the first biometric crab paper "On certain correlated Variations in *Carcinus moenas*" (15) was issued in this year. In this paper Weldon confirms on the shore crab his results for the common shrimp. The distributions of characters are closely Gaussian with the exception of the relative frontal breadth, which Weldon considered dimorphic in Naples, a problem which led to the present writer's first paper in the *Contributions to the Mathematical Theory of Evolution.* It is right to say that Weldon had reached a moderately accurate solution by trial and error before he proposed the problem to his colleague. He does not refer to this fact in his memoir. As for shrimps the correlations again came out closely alike for the Plymouth and Naples races. Weldon was not dogmatic on the point; he considered the constancy as at least an "empirical working rule" and this it has certainly proved.

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* In the summer of 1905 a great deal of work was done by the present writer in conjunction with Weldon on mixtures of card packs, the main features of the work having been already outlined by Weldon. The results are summed up in a theory of determinantal inheritance which, it is hoped, will be eventually published.

> "The question whether this empirical rule is rigidly true will have to be determined by fuller investigation on larger samples; but the value of a merely empirical expression for the relation between abnormality of one organ and that of another is very great. It cannot be too strongly urged that the problem of animal evolution is essentially a statistical problem: that before we can properly estimate the changes at present going on in a race or species we must know accurately (*a*) the percentage of animals which exhibit a given amount of abnormality with regard to a particular character; (*b*) the degree of abnormality of other organs which accompanies a given abnormality of one; (*c*) the difference between the death rate per cent. in animals of different degrees of abnormality with respect to any organ; (*d*) the abnormality of offspring in terms of the abnormality of parents and *vice versâ.* These are all questions of arithmetic; and when we know the numerical answers to these questions for a number of species we shall know the deviation and the rate of change in these species at the present day—a knowledge which is the only legitimate basis for speculations as to their past history, and future fate."

These concluding words were surely epoch-making; they formulated the fundamental principles of biometry. We may criticise the memoir in that the index measurements selected by Weldon overlooked the question of spurious correlation, or because the growth law of the indices had not been previously determined. But these are minor matters compared with the general ideas involved in the memoir. It is a paper which biometricians will always regard as a classic of their subject. It first formulated the view that the method of the Registrar-General is the method by which the fundamental problems of natural selection must be attacked, and that is the essential feature of biometry.

Besides biometry a new bond drew Weldon and the present writer together. Since 1884, a strong movement for the reform of the University of London had been in progress, association followed on association, royal commission on royal commission. Few people had distinct ideas of what they themselves wanted, scarcely any one had a notion of what a real university must connote. At University College, after severe crises, the teaching staff had won direct representation on the governing body, and was beginning to insist upon being heard in the question of university reform. One of the most vigorous protagonists in this matter was Lankester, and his removal to Oxford threatened the little group who had definite notions of academic reform with complete defeat. Luckily Weldon joined us and his energy and enthusiasm were of immense service. We had to fight our own College authorities as well as outside influences. It is not now the fitting occasion to tell the complete history. A joint letter to the *Times* roused the authorities, there were rumours of dismissal from chairs, and of wiser counsels prevailing solely at the instance of a distinguished Liberal statesman then on the College Council. The authorities were supporting a scheme which would have united King's and University Colleges in a second-rate and duplicate London University to be termed the Albert University, and rebellion had to go to extremes, if this project was to be defeated. Weldon with the help of one or two colleagues circularised every member of the College, and the night before the discussion of the charter a widely signed petition against it was in the hands of every member of the House of Commons; the Albert charter was dead, and the College Council hopelessly defeated.

The destructive attitude was now dropt; at a meeting in Wimpole Street, Weldon, G. Carey-Foster and the present writer drafted the scheme, afterwards accepted with small modifications, of an "Association for Promoting a Professorial University for London." The idea was to bring all the London teachers into one camp, to get them to accept a common ideal, and to enlist support for it among thinking men outside. The ideal was the foundation of a university in which teaching should be done by the university professors only, who should largely control the university; the separate colleges were to be absorbed. The aim was thus expressed:

> "The creation of a homogeneous academic body with power to *absorb*, not to federate existing institutions of academic rank, seems the real solution of the problem. An academic body of this character might well be organised so far as teaching is concerned on the broad lines of a Scottish University. Such a corporation may be conveniently spoken of as a professorial university to distinguish it from a collegiate or federal university."

The Association met a real need, the London teachers to our surprise and joy joined readily. We got the support of great names in literature and science. We produced a distinct effect on public opinion and by our witnesses even on the Royal Commission. But we considered that we ought to have a leader of great name, and we asked Huxley to be president. Huxley accepted, and came to us with views diverging to some extent from those of the initiators of the Association. Instead of holding up an ideal of academic reform, his plan was to find the minimum which would be accepted by various opposed interests and compromise on the basis of this. The alternatives were a long campaign to impress the powers that be with true notions of academic life, or the immediate acceptance of a teaching university, which should be an *omnium gatherum* of all the teaching institutions in London. The present writer resigned the secretaryship of the Association, and was succeeded by Weldon. It was only after very anxious consideration that the open letter of the former to Professor Huxley of December 3, 1892, was sent to the *Times**. It was a course which Weldon strongly condemned.

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* *Personal* requests to join the Association had been made to many on the basis of a circular containing the words cited above, the spirit of which was directly repudiated by Huxley.

At a general meeting of the Association held on December 21, 1892, the report of the Executive Committee was received, and after a strong speech from Huxley, adopted. It was then moved by Pearson, and seconded by Unwin: "That the Association trusts that its Executive Committee will persevere in its efforts to establish as far as possibly may be a professorial as distinguished from a federal university." This was carried. At the meeting of the Executive Committee on January 24, 1893, the President presented his own scheme for a teaching University for London; a vague motion to prepare a scheme to be submitted to the Association was, at the instance of Pearson, seconded by Lankester, amended as follows: "That the Committee prepare a scheme to be submitted to the Association in general accordance with the proposals adopted by the Association." This was carried. On January 25, 1893, Huxley wrote withdrawing his scheme on the ground that the amendment moved by Pearson and seconded by Lankester was "incompatible with any progress towards attainable ends." At the following meeting of the Committee in February, Professors Carey-Foster, Rücker, and Pearson were asked to prepare a scheme embodying the principles of the "proposals" of the Association as a basis for the charter of the proposed university. Mr Dickens and Professor Weldon were added to this committee. The scheme was actually prepared and Weldon aided with yeoman service in the drafting of it*. But the influence of the Association was dead; it never recovered from the divisions thus manifested in its executive. The spirit of compromise and the fatal easiness of federation dominated the situation and the present University emerged out of the chaos. No one felt more bitterly than Weldon the contrast between the original ideal and the result achieved. In fact, it is not too much to say that the greatest hopes for the University, and its most progressive steps since its incorporation, lie in the endeavours made to carry out in part the ideal of a homogeneous professorial university, as it was originally developed one Sunday evening in the house in Wimpole Street, and later substantially reproduced in the proposals of the Association.

This account of one movement, however, with which Weldon was closely concerned would not be justified here, did it not illustrate strongly a marked characteristic of the man. He found his great leader attacked, as he and some others believed, unwarrantably. He wrote one very strong private letter on the point, and never referred to the matter again; not the slightest breach was caused in his friendship, and the biometric talks, the common work and plans for work were resumed a day or two afterwards as if no source of friction had for a moment arisen. Yet Weldon always felt deeply, and felt this attack on Huxley more than many men would feel a direct personal attack on themselves.

With the death of Huxley in 1895, the Association practically came to an end. Weldon succeeded his hero in 1896 as Crown nominee on the Senate of the University; here, as on the Board of Zoological Studies of the later reconstituted

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* The scheme was printed and adopted by the Association, March 23, 1893.

University, he continued to work and fight for truer ideals of academic administration.

As an administrator and committeeman Weldon combined geniality with strong convictions; he saw at once through flimsy pretexts, and expressed clearly and concisely his own point of view,—"An impulsive loveable man going to the heart of any subject immediately, and always speaking up with great feeling for what he thought right," is how one of his former colleagues aptly describes him. But he lacked several of the essentials which go to make the completely effective committeeman. He was always full of the current piece of research and he grudged all time taken from it; to carry through his own projects he did not adopt the manner of the bull and crush down all opposition; some few men can do this, but it needs not only physique, but its combination with very dominant intellectual power; nor had he the persistency of the corncrake, to wear down his colleagues by continual nagging; nor silent in committee would he molelike be active underneath, "lobbying" his men, and thus more effectually work his will. These types I have known and each was less loved, but more successful than Weldon. He "played the game," threw firmly and well the lance for the cause he thought right, and went his way. He remained to the end the public school or 'varsity lad, whom the idea of "good form" controlled; but unfortunately the type is not so persistent in practical life that it dominates scientific or academic politics. From this standpoint Weldon's death removed from the field a healthy administrator, who acted as a tonic upon weaker colleagues. It was in this sense that he did excellent work, not only on various bodies connected with University College and the University of London, but on the Council of the Royal Society (1896–8), and on its Government Grant and Sectional Committees.

To the biometrician, perhaps, the most interesting committee with which Weldon was associated in these years was that which came later to be called the Royal Society Evolution (Animals and Plants) Committee. It is somewhat difficult to give the full history at present, but some attempt at a sketch of Weldon's connection with it must be made here. Weldon's papers on variation and correlation in shrimps and crabs had brought him closely in touch with Francis Galton, and both were keenly interested in the discovery of further dimorphic forms such as had been suggested by the frontal breadths of the Naples crabs. Weldon was full also of other ideas ripe for investigation. He had started his great attempt at the measurement of a selective death-rate in the crabs of Plymouth Sound; experiments on repeated selection of infusoria were going on in his laboratory; he was gathering an ardent band of workers about him, and much seemed possible with proper assistance and that friendly sympathy which was ever essential to him.

The idea that a group of men can achieve more than a single investigator, if true in some forms of social work, is rarely applicable to scientific committees; but such committees have often been tried in the past, and will no doubt be again attempted in the future. If used as instruments of research, the work done is too often a compromise between different methods and divergent personalities; if merely administrative they are successful or not, according to the width of view of some dominating temperament. If run in the interests of one school, still more of one individual, a committee may no doubt do good work, but it is likely, at the same time, seriously to damage the reputation of any larger body in whose name it works, by too markedly connecting it with one aspect of a problem or one side of an unsettled controversy. These difficulties of the situation seem only by degrees to have come home to the founders of the Evolution Committee.

The project was first discussed informally by R. Meldola, Francis Galton, and Weldon, at a meeting held on the 9th of December, 1893, at the Savile Club. Francis Darwin, A. Macalister, and E. B. Poulton had expressed themselves willing to assist such a project. It was settled that a proposal should be made to the Royal Society for the formation of a committee "For the purpose of conducting Statistical Enquiry into the Variability of Organisms," the members suggested being F. Darwin, F. Galton, A. Macalister, R. Meldola, E. B. Poulton, and W. F. R. Weldon, to whom "it may afterwards be desirable to add a statistician." It was resolved further to ask for a grant of money to obtain material and assistance in measurement and computation.

A Committee* consisting of these members was finally constituted by the Council of the Royal Society, with Francis Galton as chairman and Weldon as secretary, the Committee being entitled: "Committee for conducting Statistical Inquiries into the Measurable Characteristics of Plants and Animals." The use of the words *statistical* and *measurable,* somewhat narrowly, but accurately, defined the proposed researches of the Committee. It went on until 1897, with these members, the same title and scope. Then in the early part of that year its scope was much extended by adding to its objects the "accurate investigation of Variation, Heredity, Selection, and other phenomena relating to Evolution," and W. Bateson, S. H. Burbury, F. D. Godman, W. Heape, E. R. Lankester, M. Masters, Karl Pearson, O. Salvin and Thiselton-Dyer were added to its number. But at present our account must deal with the earlier biometric period of the Committee. Looking back on the matter now, one realises how much Weldon's work was hampered by this Committee. It is generally best that a man's work should be published on his own responsibility, and when he is a man of well-known ability and established reputation, grants in aid can always be procured. In this case Weldon had a sympathetic committee, but the members were naturally anxious on the one hand for the prestige of the Society with whose name they were associated, and secondly, they were desirous of showing that they were achieving something†. Both conditions were incompatible with tentative researches such as biometry then demanded. Trial and experiment were peculiarly needful in 1893; the statistical calculus itself was not then even partially completed; biometric computations were not reduced to routine methods, and the mere work of collecting, observing, experimenting, and measuring was more than enough for one man. Weldon with his "volume of life" was eager to do all these things, and run a laboratory with perhaps sixty students as well. He was impatient because the probable errors of biometric constants, on which tests of significant differences depend, were not at once forthcoming; he wanted the whole mathematical theory of selection, the due allowances for time and growth, the treatment of selective death-rates and the tests of heterogeneity and dimorphism settled in an afternoon's sitting. The Committee did not possess a mathematician to put on the brake, and Weldon attempted too much in too short a time. Each week Weldon had new and exciting problems, he thrust them upon his friends, demanded solutions, propounded solutions, and was never discouraged when difficulties were pointed out and time asked for.

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* First meeting, January 25, 1894.

† "Of course these considerations only make the problem more interesting than it was before: and I very much want to solve it. But the committee may say that it requires a problem which is reasonably certain to yield an adequate solution in a fairly short time, and that so risky an attempt as this is not suitable for its present work." Letter of Nov. 13, 1894, relating to the secretion of a specific poison by *Daphnia.*

One of the first subjects to be taken up by the new Committee was to test whether the method of resolution into two Gaussian curves, which suggested dimorphism in the Naples crabs, would be helpful in confirming a similar dimorphism said to exist in the herring. Several thousand herrings arrived at University College, a measurer was trained to deal with them, and the variability of a wide series of characters determined. The distributions came out skew, and Weldon was intensely hopeful that statistical evidence of dimorphism would be forthcoming. Instead of this, the analysis showed dimorphic Gaussian components to be impossible. This result was a great disappointment to him, and, I believe, to the Committee. I could never understand why. A most extensive and valuable series of measurements had been made, which in themselves were well worth publishing. It had been shown that simple dimorphism of a Gaussian kind certainly did not hold for these herrings; in all probability it was a typical case of skew frequency, which would have been most valuable as adding to the known instances, and aiding statisticians eventually to classify such occurrences. But Weldon, and, I presume, the Committee were disheartened, they had been searching for dimorphism and had not found it. The herring data were put on one side by Weldon, and as far as I know have never been published. It is much to be hoped that they may some day be resuscitated from the archives of the Committee (16).

The next point that I personally became aware of in relation to the Evolution Committee was Weldon's attempt to solve the problem of subraces in the case of the ray florets of ox-eyed daisies. I am unaware who brought the material before the Committee, but it was obviously heterogeneous in the highest degree. There was no evidence at all that any attempt had been made to allow for seasonal and environmental effects, and whatever truth there may be in a tendency of the modes to fall into Fibonacci groups, we now know that varying season and period will produce within a certain range almost any mode in this flower*. To break up such a heterogeneity even into Gaussian components was a problem not then solved, and one which has not since been solved. It was cruel fate that thrust such a problem on Weldon, and kept him over it for weeks. He was struggling with most highly complex mathematical difficulties, and actually beginning with a problem which a more highly trained mathematician would certainly have put on one side in the then state of statistical analysis*.

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* *Biometrika*, Vol. I. pp. 305, 309 *et seq.*

The next portion of the Committee's work was far more successful—the "Attempt to Measure the Death-rate due to the Selective Destruction of *Carcinus moenas*, with respect to a Particular Dimension" (17). This formed the first report of the Committee, and was presented to the Royal Society in November, 1894. Weldon's general project in this case was, I believe, absolutely novel at the time, and embraces, I consider, the best manner still of testing the truth of the Darwinian theory. It consists in determining whether the death-rate is correlated with measurable characters of the organism, or, as he himself put it, "in comparing the frequency of abnormalities in young individuals at various stages of growth with the frequency of the same abnormalities in adult life, so as to determine whether any evidence of selective destruction during growth could be discovered or not."

Thus stated the problem might appear an easy one, but it is the very reverse. How is the 'abnormality,' i.e. what we should now term the deviation from type, to be measured at each stage of growth? What is to determine 'adult' life? What measure is there of the time during which the individual adult life has been exposed to the selective destruction? Weldon undoubtedly chose the crab because of the facilities it offers for measurement. But its age then becomes an appreciation based merely on the obviously close, but probably imperfect correlation between age and size. Further, the law of growth, complicated rather than simplified by the moults, and the question as to how far the variability of the characters dealt with is affected by growth combine, in the case of crabs, to form an exceedingly difficult problem. It is practically impossible to keep a sufficiently large series of crabs through the whole period of adolescence, and if it were possible, it is far from certain that the claustral environment necessary would not sensibly affect their law of growth.

Looking back now on Weldon's paper of 1894, one realises its great merits; it formulates the whole range of problems which must be dealt with biometrically before the principle of selection can be raised from hypothesis to law. Almost each step of it suggests a mathematical problem of vital importance in evolution, which has since been developed at length, or still awaits the labour of the ardent biometrician. On the whole, I think, Weldon came very near to demonstrating his point, but whether he did or did not scarcely affects the suggestiveness of the paper†.

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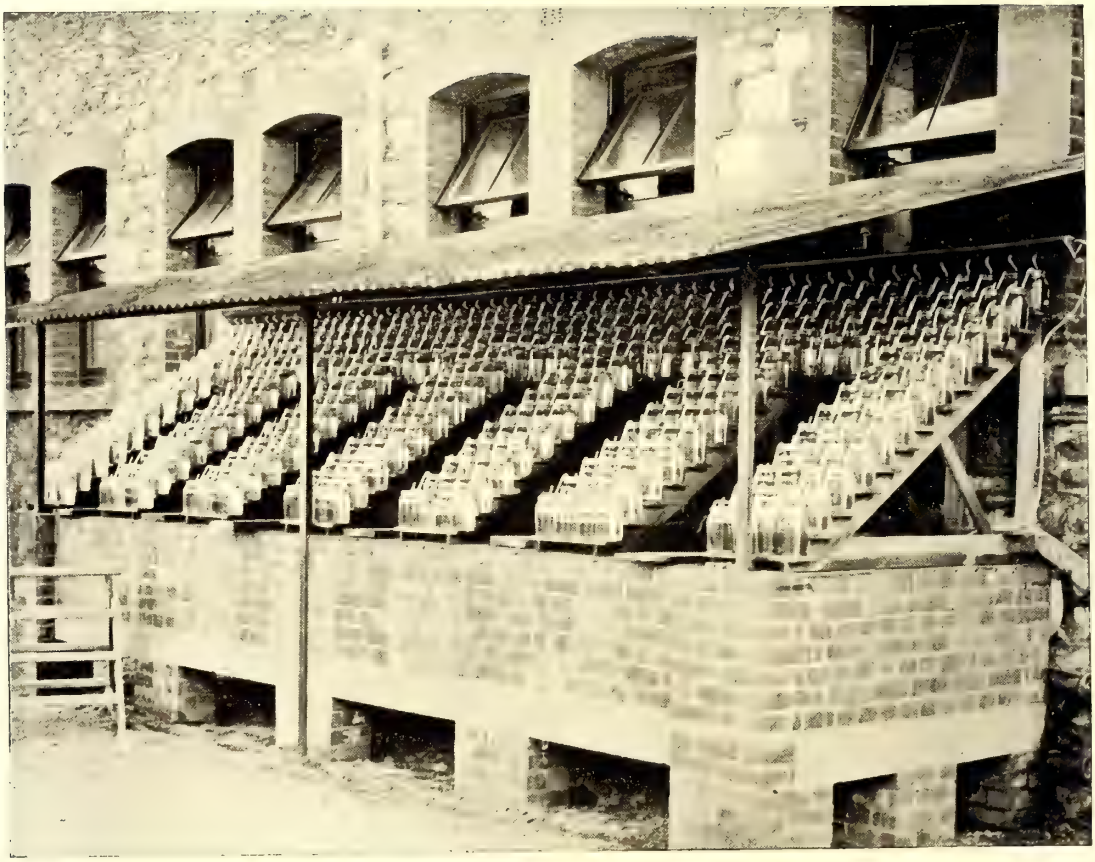
* We now know that some of the most skew distributions are given by the parts of flowers, and the problem propounded to Weldon was to resolve into a number, probably five or six, of such skew components a strikingly irregular frequency distribution for ray florets!

† Reading through the criticisms I communicated to him at the time, criticisms written purely from

Unfortunately the paper, as well as the suggestive "Remarks on Variation in Animals and Plants" (18), with its memorable words :—"The questions raised by the Darwinian hypothesis are purely statistical, and the statistical method is the only one at present obvious by which that hypothesis can be experimentally checked"—fell on very barren soil. The paper produced a mass of criticism—folios were written to the Chairman of the Committee, showing how this, that or the other vitiated entirely the results. The very notion that the Darwinian theory might after all be capable of statistical demonstration seemed to excite all sorts and conditions of men to hostility. Weldon, instead of being allowed to do his own work in his own way, had to be constantly replying to letters, some even eighteen sheets long, addressed to the Chairman of the Committee. These letters were not sympathetic and suggestive, but mostly purely controversial. The need for further investigation of the law of growth had been frankly admitted by Weldon in the "Remarks" issued at the discussion on the "Report," but the critics declined to wait for answers till further results were published. This attack lasted for the next three years, during which further researches on the selective death-rate and growth of crabs were carried out, and it formed a serious impediment to calm progressive investigation. A further instructive report (19) on the growth at two moults of a considerable number of crabs was made to the Committee in 1897, but I believe has never been published. Later, an account of work on Natural Selection in crabs was given by Weldon in his "Presidential Address to the Zoological Section of the British Association," Bristol, 1898 (20).

In this paper Weldon returns to the problem of whether frontal breadth in crabs is correlated with a selective death-rate, but he now deals with type and not variability. He first approaches the problem from the consideration of whether for this character the crabs in Plymouth Sound are remaining stable, and he shows from measurements made by Sir Herbert Thompson and himself during the years 1892 to 1896, that the population is unstable. He next seeks a cause for this secular change, and he finds it in the turbid state of the water in Plymouth Sound, due to the continual carriage into it of large amounts of china clay and sewage. Direct experiments were then made on the selective death-rate of crabs kept in water with suspended china clay and on another occasion in foul water. In all cases the survivors were found to have a smaller frontal breadth relatively to their carapace length. Confirmatory experiments showed that after the first shock of confinement was passed this selection did not occur among crabs kept in pure sea water. A reasonable explanation of this selective action was provided in the character of a crab's breathing apparatus. Thus, after several

the mathematical standpoint, I still think them valid, but I realise also how much of my own work flowed directly from the suggestiveness of this paper. In fact it was the starting-point of the whole of the work on the influence of selection on the correlation and variability of organs. The sequel to that work, the influence of selection during growth, flows equally from Weldon's paper, but although we know much more than we did ten years ago as to the laws of growth, no sufficiently general formula of growth can yet be applied to allow of the completion of Weldon's work in this direction.



A "Crabbery" at Plymouth.

years of discouragement and much hard labour, Weldon succeeded in demonstrating that natural selection was really at work, and further that it was at work at a very sensible rate*. The labour involved was excessive. One "crabbery" consisted of 500 wide-mouthed bottles, each with two syphons for a constant flow of sea water, and each crab had to be fed daily and its bottle cleaned. During the summer of 1897 Weldon spent the whole of his days at the aquarium, and his wife hardly left him except to fetch the needful chop. The sewage experiment was "horrible from the great quantity of decaying matter necessary to kill a healthy crab." In 1898 the china clay experiments were continued at Plymouth. But in the autumn a rest came. The Address was written and Weldon thoroughly enjoyed his presidency of Section D of the British Association at Bristol.

It may not be out of place here to note the great aid Weldon's artistic instinct and literary training gave to his scientific expression. His papers are models of clear exposition, his facts are well marshalled, his phraseology is apt, his arguments are concise, and his conclusions tersely and definitely expressed. The result, however, was not reached without much labour. I do not mean that it was an effort to him to write well and clearly, but that his standard was so high, that having written a memoir, he would to please his own sense of the fitting rewrite the whole of it and possibly redraw all the diagrams. Nor was the remodelled memoir necessarily in its final form. A third or fourth reconstruction might follow to satisfy his own standard of right expression. To him a paper was a literary whole, which had not only to convey new facts, but to play its part on the scientific stage,—and he was not satisfied until it was in his judgment artistically complete. There was never any artificial brilliancy introduced in the process; rhetoric in the service of science was intolerable to Weldon. It was simply an attempt to choose the suitable form and the right words for a given purpose. It was comparable with Weldon's sense of sound, with his extraordinary gift of appreciating and reproducing the exact intonation of a foreign tongue. Both were the result of observation and experiment—not manifest in the final product—guided by a trained artistic sense.

Considerable changes were soon to take place in Weldon's environment and scheme of work. Lankester had been appointed director to the British Museum (Natural History), and in February, 1899, Weldon succeeded him in the Linacre Professorship at Oxford. In the February of 1897 the Royal Society Evolution Committee received a large increase of membership; it ceased henceforth to "conduct statistical inquiries into the measurable characteristics of plants and animals." It became transformed into an Evolution (Plants and Animals) Committee. At first there were great hopes of achievement, there was a possibility of securing Charles Darwin's house as a centre for breeding experiments, and a considerable sum of money was promised in aid. Francis Galton struggled bravely for a great idea. He wanted to see the numerous bodies engaged in horticulture and zoology coordinated in at least one aspect of their work, and that research of a scientific kind should be introduced into the proceedings of each of them. He strove to make two schools, widely diverse in method and aim, understand each other. He wanted to keep individuals and societies up to their work, and prevent overlappings. But it was not to be. The members were pulling in opposite directions, there was too much friction, and too little compromise. A false antithesis was raised between what was termed "natural history" and any sort of statistical inquiry leading to numerical results. The biometric members ceased to attend regularly and finally resigned towards the end of 1899. Thiselton-Dyer and Meldola also left the Committee, which became from that date confined to one special school and one limited form of investigation. From beginning to end the Committee has, in the opinion of the present writer, been a mistake; not only because at first it distinctly forced the pace and hampered Weldon's work, but because experience shows that such a committee can only work effectually in the interests of one school of ideas, and this, whatever safeguards may be taken, has at least the appearance of destroying the impartiality of the parent body, a matter of very grave importance.

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* The 60,000,000 years or so, which the physicist then allowed the evolutionist, were at that time a little more of an incubus than they are now !

During the eight years of Weldon's London professoriate his development was great; he became step by step a sound mathematician, and gained largely in his power of clear and luminous exposition. His laboratory was always full of enthusiastic workers, and over forty memoirs were published by his students, who included E. J. Allen, E. T. Browne, F. Buchanan, G. H. Fowler, E. S. Goodrich, H. Thompson, E. Warren, and others of known name. The following lines, provided by a friend, graphically recall Weldon in his early London days:—

> "In so vivid a personality it is hard to point to the period of greatest mental activity, but of the nineteen years in which I knew him I should select the first few years of his Professorship at University College, London. Fresh from contemplative research at the Plymouth Laboratory of the Marine Biological Association, and with his mind full of the new problems to which the study of marine life had introduced him, he threw himself into teaching with renewed zest. The effect on his students was amazing; most of them began a zoological course as a compulsory but annoying preliminary to a degree; Weldon soon changed that. Without ever forgetting the requirements of examinations, he made the subject alive and absorbing; his advanced classes soon filled up; and while on the one hand, the scholarships at London University were always claimed by his students, on the other the output of original investigation published by his department was one of which no university need have felt ashamed. Besides all this his students loved him; he was so intensely human....Into the question of remodelling the University and the defence of his College, Weldon threw himself as if unencumbered with arduous teaching and research; his notably lofty ideals and vigorous championship were far from being wasted; but his removal to Oxford at the time of the birth of the new University was a severe loss to the cause of real education in London. Gentle with ignorance, he was fiercely intolerant of educational shams and cants."

As the present writer has indicated, the stress during these London years was very great—the struggle with new mathematical processes, the wear of incessant calculation, the worry of unending controversy to a man fully occupied with research and teaching, all told on Weldon. The holidays were more limited in extent, but were very varied in character. In 1893, Easter was spent in the Sieben Gebirge; the Weldons were up at six, calculating till one, and starting a great tramp at two, from which they returned at eight. The autumn they spent in Venice, going by sea, and the Christmas at Brussels, with opera each night and walks to Waterloo most days. In 1894 it was Siena for the Palio, with a knapsack tour from Stresa to Alagna by Orta and Varallo. In 1895 Easter found them fossil-collecting in the Eiffel, and, after the hard summer at Plymouth, in the Apennines, winding up in Florence. Bicycling was the rule in 1896, even cycling from Wimpole Street to Plymouth, and the only holiday a cycling tour in Normandy. In 1897 there was an Easter visit with architectural sketching to the cathedrals of North-East France, and after the specially hard summer at Plymouth a trip to Perugia and a return from Genoa by sea. The last year in London included a butterfly and moth collecting expedition to Ravenna at Easter, but no summer holiday abroad; the British Association, followed by a study of Wells Cathedral, occupied its place. The restlessness of work seemed to have overflowed into the holidays, and Weldon's friends knew that it was telling upon him, and trusted that Oxford life might be quieter than the London life had been.

VI. *Oxford and the Second Professoriate,* 1900—1906.

The removal of Weldon from the London field of work, while an incalculable loss to his colleagues, was not without compensation to his nearest friends. They knew that the life of the last few years had been one of great tension, that Weldon's time had been too much encroached upon by committee work, that the separation between the locus of his teaching and of his research work was very undesirable, that even the social life of London involved too much expense of energy. Oxford, in some respects, would present a narrower field of administrative duties; it would provide a roomy and amply equipped laboratory, where experiments hitherto shared between Plymouth and Gower Street could be carried out, and remain under control while ordinary teaching work was going forward. Even the social life in Oxford had more regular hours and was less over-stimulating. It is true that Weldon occasionally regretted the contact with many minds working on kindred topics, and even the stimulus of keen men working on quite different subjects, which is characteristic of the metropolis. He would speak with great affection of "dear old Gower Street, where everybody was working and everybody wanted to work"—and he would be vexed that so many of "these nice Oxford boys" had no *res angusta domi* to force them from the river and the playing field into the laboratory and the lecture room. "They are so nice, they come to my lectures because they think it would be rude to leave me alone." The lad who would not make a sacrifice to his love of science—accept an Asiatic appointment of the merest bread and butter value, or take passage in a tramp steamer to collect in South America—was anathema to him. He wanted everywhere an infant Huxley, realising the value of tropical or semi-tropical observation and experience and anxious to seize the opportunity of it at any slight personal inconvenience. Weldon did not grasp that it was largely his own personality which had created the band of earnest workers round him in London, and that with time it would be effective in more conservative Oxford. He did not realise that the over-stimulus of the London period, with its midnight hours and incessant interchange of ideas, would be better replaced by the more leisurely intellectual and more regulated social life of Oxford.

There is another point which emphasises the value of this change. Weldon's taste, his whole emotional nature, made him essentially a field naturalist. It was no innate taste for figures or symbols, no pleasure in arm-chair work, which drew him to statistical research. Nor was it the influence of any personality. On the contrary, he was impelled to it by the feeling that no further progress with Darwinism could be made until demonstration from the statistical side was forthcoming. His biometric friendships arose from the direction he felt his work must take. He distrusted mathematicians as much as any good Mendelian might do; they were persons who neither observed nor experimented, who had "a true horror of a real measurement." Acceptance of each stage of biometric theory could only be won from Weldon by a tough battle; it had first to justify its necessity, and next to justify its mathematical correctness. He was not drawn into actuarial work by his sympathies or his friendships, he was *driven* into it by the looseness he discerned in much biological reasoning; he felt an *impasse*, which could only be surmounted by the stringency of mathematical logic. Those who have known Weldon collecting on the shore, dredging at sea, or in later days sampling ponds and wells for his *Crustacea* book, photographing snail environments in Sicily, or hunting for *Clausilia* in the woods at Risborough or Plön, realise that he was in the first place the open-air naturalist. If further evidence be indeed wanting, let the following words provide it:

[*April*, 1903.]

"Just back, and have just read your letter. I will play with the spanner and talk of it to-morrow.

I did not telegraph because our office was shut. It was a great disappointment to miss you; but the ride was the one thing I enjoyed out of the last three weeks. I have felt nothing like it since the old days when I used to lie in a fishing boat dodging the squalls off Rame Head or the Deadman, when we were all young and arithmetic was not yet. That is all gone. The good old man I used to sail with went to haul lobster pots in one of the March gales, and his boat was found bottom upwards.

He was a good soul. 'Yes, my dear,' he used to say in a breeze; 'we'll shake out all them reefs if you like. You'll get wet, but I'm only a fisherman and wet don't hurt me.' Then he would sing Devonshire songs while the water came over the gunwale, till you went on your knees to him to ask for at least one reef back again.

Really, even Basingstoke railway station looked good with the squalls climbing round it. *Ride* home. It will do you no end of good. Go by Farnham, Basingstoke, not by Guildford. Sandro and I rode home to-day. We had no snow, and no rain, and not half the fun of Monday. A sober, middle-aged ride on a good road in good weather.

Nevertheless, my head is so full of chalk-downs and clouds, and things, I can't write biometry to-night. Always, when I have been with the country, the feeling breaks out that the other folk have the best of it. The other way you live with the country and become part of it; and you dredge, or fish, or shoot something wonderful, and you describe it, and everyone sees that it is wonderful, and you all enjoy the wonder. And there is no solution, and if there were, it would not be worth the shadow of a shower flying across the country.

And this is all wicked nonsense, and I am going to bed. Yours affectionately,

W. F. R. WELDON."

Weldon was a child of the open air and the breezes, and we hoped that he might have more of them, if not in lowland Oxford, at least on the hills around. There was space and air too for the experimental work that had been so cramped in Gower Street. The *Daphnia* studies, which had occupied so much energy under unfavourable conditions in London, were at once resumed on broader lines in the ponds and ditches round Oxford. Weldon, with a basket of bottles attached to his cycle handle, and a fishing creel, filled with more bottles, on his back, might be met even as far as the Chilterns, collecting not only *Daphnia*, but samples of the water in which they lived. His University College work had shown him how widely *Daphnia* are modified by their chemical and physical environment, and how this modification is largely due to selection. There exist elaborate drawings of the *Daphnia* from the Oxfordshire ponds, indicating their differentiation into local races, and notes on the peculiarity of their habitat and the chemical constitution of the water:

"In the meantime I have been led into a non-statistical work for the moment. Get out of the library and read Klebs : *Bedingungen der Fortpflanzung bei einigen Algen und Pilzen.*

By tricks of nutrition, light, etc., Klebs can make simple algae reproduce either a-sexually or sexually, or parthenogenetically, as he pleases. In cases where every textbook tells you that a regular alternation of sexual and a-sexual generation is the rule, he can make *either* form recur as often as he likes.

If one can by similar tricks throw *Daphnia* into this condition, then the measuring machine can again come into play, and one can compare parthenogenetic inheritance with sexual inheritance as often as one pleases.

That is a *Nebensache.*—The *Hauptsache* here is the great variation in the chemical composition (pardon the phrase) of the water in the little rivers. Their percentage of dissolved salts varies enormously, and I hope to go about as I have begun, with a large fisherman's creel tied to the handle-bar of my bicycle, learning the correlation between the salts in the waters and the fauna.—Then again comes the measurement, and the attempt to derive one local form from the other under controlled conditions by direct selective destruction due to the conditions."

This was precisely the same problem which a study of Kobelt's *Studien zur Zoogeographie*, 1897–9, led him later to take up with regard to land snails. What is the meaning of the slight but perfectly sensible differences in type to be found in shells from adjacent valleys, or even from different heights of the same mountain? Weldon attacked the problem in his usual manner; he spent two Christmas vacations collecting Sicilian snails of the same species from habitats extending over a wide area, the local environments were described, and the snails often photographed with their immediate surroundings. Innumerable shells were brought back to Oxford, and Weldon delighted to discourse on the significant differences in local type, and yet the gradual change of type to type from one spot to another. No rapidly made measurement on the outside of the shell would satisfy Weldon; the shell must be carefully ground down through the axis, and measurements made on the section thus exposed. Perhaps four or five snail shells could be ground and measured in a day, and at the time of his death, not more than a few hundred of the Sicilian thousands had even been ground. Like the *Daphnia,* the Sicilian snails remain as an indication of the way—the path of absolute thoroughness—the master would have us follow. "Life is not long enough for biometry," murmurs the superficial critic. But the man of deeper insight replies:

That low man goes on adding one to one,
  His hundred's soon hit:
This high man, aiming at a million,
  Misses an unit.

But these attempts to get to the kernel of selection in its action on local races were far from occupying the whole of Weldon's thoughts in these early days. In conjunction with his assistant, Dr E. Warren, he had commenced at University College his first big experimental investigation into heredity.

> "The Oxford rivers have had to rest during the last few weeks, because of the pedigree moths. These are apparently going on very well indeed. There are at present about 3500 caterpillars, belonging to thirty-eight families forming the third domesticated generation."

The characters to be dealt with consisted of the number of scales in particular colour patches, and the work of counting these was very laborious. A little later (16 July, 1899) Weldon writes:

> "The caterpillars are hatching by hundreds and I hope the clean air will help them to do better here than in London. From egg to moth, poor Warren, in spite of magnificent efforts, had a death-rate of over eighty per cent.; and that seems to me a rather serious thing...because one cannot be sure that the death-rate was not partly selective with respect to things in the caterpillar which are correlated with colour in the moth. The influence of climate is shown by the fertility of the eggs—Warren got forty per cent. of fertilised eggs from his pairing and an average of over one hundred eggs per batch. Nearly all my pairs lay fertile eggs and those I have counted give an average of one hundred and sixty-five eggs per batch."

And again, on the 14th August of the same year:

> "I want to come and talk to you, especially about death; but I cannot come till my caterpillars are safely turned into pupae. For the sake of these caterpillars I have, at the risk of personal liberty and reputation, stolen from the roadside one hundred square feet of clover turf, the property of the Lords of various Manors in this neighbourhood. The little ruffians have now eaten all this clover and for the last day or two of their existence have to be fed by hand.—Therefore I have to pluck fresh clover (which is not stealing if you do not do it in an enclosed pasture) every day.—My bicycle is nearly worn out from carrying extra weight. Riding down a steep hill, with your brake smashed, and with five or six feet of heavy turf on your back is like playing at Attwood's machine. You get very near to the theoretical acceleration too!"

In the course of three years many hundreds of pedigree moths were dealt with and the observations were reduced. But *no definite inheritance at all of the character selected for consideration was discovered.* Weldon, I believe, thought that there had been some fatal mistake in the selection of pairings, and undoubtedly in some cases parents of opposite deviation had been mated, so that a rather influential negative assortative mating resulted. But from other series of pedigree moth data that I have since seen, it seems to me probable that there is some special feature in heredity in moths, or possibly in those that breed *twice* in the year, and that the vast piece of work which Weldon and Warren undertook in 1898—1901, may still have its lesson to teach us. At the time it formed another link in that chain of apparent failures which for a time, but only for a time, disheartened Weldon.

In these three first years at Oxford, Weldon's intellectual activity was intense. The letters to the present writer, which in 1899 averaged one a week, in 1900 and 1901 reached an average of two, and in some weeks there were almost daily letters. These letters not only teem with fruitful criticism and suggestion with regard to the recipient's own work, but contain veritable treatises—drawings, tables, calculations—on the writer's own experiments and observations. To the pedigree moth experiments was added in the summer of 1900 an elaborate series of Shirley Poppy growings, 1250 pedigree individuals being grown and tended in separate pots; Weldon's records were the most perfect of those of any of the cooperators, and his energy and suggestions gave a new impetus to the whole investigation. They were ultimately published in *Biometrika* under the title, *Cooperative Investigations on Plants*, I. *On Inheritance in the Shirley Poppy* (22). As Weldon himself expressed it, the moths and poppies meant "a solid eight hours daily of stable-boy work through the whole summer, and through the Easter vacation, with decent statistical work between." The autumn of 1899 provided no proper holiday, but Christmas found the Weldons in Rome. After the Shirley Poppies were out of hand in the summer of 1900, the Weldons went to Hamburg and thence to Plön. The object of this visit was to collect *Clausilia* at Plön and Gremsmühlen for comparison with the race at Risborough. The same aim—the comparison of local races—led Weldon at Christmas to collect land snails in Madeira. Thus he slowly built up a magnificent biometric collection of snail shells—i.e. one sufficiently large to show in the case of many local races of a number of species the type and variability by statistically ample samples. Of this part of Weldon's work only two fragments have been published, "A First Study of Natural Selection in *Clausilia laminata* (Montagu)" (23), and "Note on a Race of *Clausilia itala* (von Martens)" (24). In the first of these memoirs Weldon shows that two races of *C. laminata* exist, in localities so widely separated as Gremsmühlen and Risborough, with sensibly identical spirals, although no crossing between their ancestors can have existed for an immense period of time, and although there are comparatively few common environmental conditions. At the same time, while no differential secular selection of the spiral appears to have taken place during this period, there yet seems to be a periodic selection of the younger individuals in each generation, the variability of the spirals of the young shells being sensibly greater than that of the corresponding whorls of adults. In other words stability to the type is preserved by selection in each new generation.

In the second memoir Weldon sought for demonstration of a like periodic selection in the *C. itala* he had collected from the public walks round the Citadel of Brescia. He failed, however, to trace it, and was forced to conclude that *C. itala* is either not now subject to selective elimination for this character, or is multiplying at present under specially favourable conditions at Brescia, or again, as both young and old were gathered in early spring, after their winter sleep, that elimination takes place largely during the winter, and "that individuals of the same length, collected in the autumn, at the close of their period of growth, might be more variable than those which survive the winter."

Quite apart from the results reached, Weldon's papers are of the highest suggestiveness. Does selection take place between birth and the adult or reproductive stage? This is the problem which everyone interested in Darwinism desires to see answered. But to answer it we need to compare the characters of the organisms at the same stage of growth, for these characters are modified by growth. How is it possible to compare a sample of the race at an early stage, with its adult sample? The problem of growth, to be studied only under conditions of captivity, possibly modifying the natural growth immensely, had made the crab investigation an extremely complex one. Weldon solved the difficulty by the brilliant idea that the snail carries with it practically a record of its youth. If the wear and tear of the outside of the shell to some extent confuses the record there, a carefully ground axial section will reveal by the lower whorls the infancy of the organism. Hence the days given to experimental grinding, the training in manipulation and the final success, and then the steady work, grinding and measuring a few specimens a day, till the necessary hundreds were put together; the laborious calculations not in the least indicated in the papers—the arithmetical slips with bad days of depression, and the completed result: the illustration of how shells may be used—by those who will give the needful toil—to test the truth of the Darwinian theory.

The summer of 1899 found the present writer at Great Hampden on the Chilterns, working at poppies and developing a theory of homotyposis, namely, the quantitative degree of resemblance to be found on the average between the like parts of organisms. Weldon, who came over from Oxford to dredge the ponds and to discover *Clausilia* by the White Cross at Monks Risborough, provided the criticism, suggestion, and encouragement, in which he never failed*:

> "You have got hold," he wrote, after returning to Oxford, "of the big problem which all poor biologers have been trying for ever so long. I wish you good luck with it."

The collection and reduction of material were on a larger scale than had been previously attempted, and the memoir was not presented to the Royal Society until the October of the following year (1900). It was soon evident that the attitude of the Society with regard to biometry was undergoing considerable change. The meeting of November 15 and the discussion that took place on the homotyposis paper was the immediate cause of the proposal to found this Journal. A little later a detailed criticism of the paper by one of the referees was actually printed by the Secretaries and issued to Fellows at a meeting, before the fate of the criticised paper itself had been notified, and before the paper itself was in the hands of those present. This confirmed the biometric school in their determination to start and run a journal of their own.

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* His aid in the second part—Homotyposis in the Animal Kingdom, shortly to be published,—was even more substantial.

On November 16 Weldon wrote:

> "The contention 'that numbers mean nothing and do not exist in Nature' is a very serious thing, which will have to be fought. Most other people have got beyond it, but most biologists have not.
>
> Do you think it would be too hopelessly expensive to start a journal of some kind?......
>
> If one printed five hundred copies of a royal 8vo. once a quarter, sternly repressing anything by way of illustration except process drawings and curves, what would the annual loss be, taking any practical price per number?... If no English publisher would undertake it at a cheap rate, the cost of going to Fischer of Jena, or even Engelmann, would not be very great."

This was the first definite suggestion of the establishment of *Biometrika*. On November 29, the draft circular, corresponding fairly closely to the first editorial of the first number (25), reached me from Oxford with the words: "Get a better title for this would-be journal than I can think of!" The circular went back to Oxford with the suggestion that the science in future should be called Biometry and its official organ be *Biometrika*. And on December 2nd, 1900, Weldon wrote:

> "I did not see your letter yesterday until it was too late for you to have an answer last night. I like *Biometrika* and the subtitle. Certainly we ought to state that articles will be printed in German, French, or Italian. One may hope for stuff from anthropologers, and —— for instance, ought to be allowed to use his own tongue."

Thus was this Journal born and christened. The reply to circulars issued during December was sufficiently favourable to warrant our proceeding further. A guarantee fund sufficing to carry on the Journal for a number of years was raised at once; good friends of Biometry coming forward to aid the editors. By June of 1901 its publication through the Cambridge University Press had been arranged for, and the sympathetic help of the Syndics and the care given by the University Printers enabled us to start well and surmount many difficulties peculiar to a new branch of science*. Those of us who believe that *Biometrika* came to stay and to fulfil a definite function in the world of science hope that the name of the man who first formulated a definite proposal for a biometric organ may always continue to be associated with our title-page. During the years in which Weldon was editor he contributed much, directly and indirectly, to its pages. He was referee for all essentially biological papers; and his judgment in this matter was of the utmost value. He revised and almost rewrote special articles. He was ever ready with encouragement and aid when real difficulties arose. For the mechanical labour of editing, for proof-reading, for preparation of manuscripts and drawings for the press, or for interviews with engravers, he had little taste or time. He was too full of his current problem to undertake work of this kind regularly; proofs might remain for weeks unopened, until the number was printed off, and manuscript might disappear into a drawer, when the co-editor imagined it was safely on its way back to the author! But Weldon was always delightful when such "laches" were discovered; to meet Weldon when he was in an apologetic frame of mind meant that you must apologise to him yourself for the very thought of scolding him! It was all over before he had shaken hands, sat down, and lighted the inevitable cigarette; you were not talking of proofs, but of Kobelt, Mendel, Maeterlinck, the *Kritik der reinen Vernunft*,—anything and everything but dull editorial matters. And you felt a freshness and a tonic, and a sense of the healthy joy and pleasure of life, and you wondered how it was possible to do anything but love this man and rejoice in the clearness of his vision and the suggestiveness of his thought.

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* A special feature has been of course the masses of tabulated numbers. It deserves to be put on record that on more than one occasion 15 or 20 pages of figures have been set up without a single printer's error.

Starting on October 16, 1900, and extending throughout the early *Biometrika* letters, runs a flood of information with regard to Mendel and his hypothesis.

"About pleasanter things, I have heard of and read a paper by one, Mendel, on the results of crossing peas, which I think you would like to read. It is in the *Abhandlungen des naturforschenden Vereines in Brünn* for 1865. I have the R.S. copy here, but I will send it to you if you want it." [*October* 16, 1900.]

Then follows a resumé of the first of Mendel's memoirs, and for months the letters—always treatises—are equally devoted to snails, Mendelism and the basal things of life. It is almost impossible to give an idea by sampling of the crush of keen and vital interest these letters represent. Some attempt must, however, be made:

"Have you ever been up here? It is not at all a bad little country when you are tired.—We started simply to see the architecture at Lübeck, because neither of us knew the North German brick and wood church work. That was very interesting, then we came here for fresh air and quiet—and we found SNAILS.

I have rather more than 5000 snails all properly pickled, with localities recorded.......There are so many points about snails, if one could only measure and breed them!...Also I have been greatly impressed with the way in which they are dependent upon conditions of environment, so that one quickly learned to know almost exactly what species one would find in any place one passed through. I think that by going from here, which is almost the eastern limit of several species, to a very different country, such as Oxford, one might almost hope to make a good shot at some of the essential conditions which determine the distribution of some of the species.... It is ridiculous that such abundant material as snails afford everywhere (except at Danby End?) should be left useless because one cannot see how to take advantage of it. Send me some "tips" for trials. (To Oxford,—we go home to-day)." [Plön, 5/9/90.]

"You ought to see Lübeck some day. You know so much about German art that I suppose the pathetic ugliness of it does not hurt you any more?......

You can't get a beautiful art in a climate where people must wear clothes. Just as the northern idea of a portrait is a round face stuck on top of a heap of fine clothes, so the northern idea of a building is a thing with all its good simple lines disguised by silly excrescences. If you want to see really majestic brickwork go to Siena or Pistoja, where you can see naked men and women in the streets on a summer's day. Lübeck is very earnest, and very interesting, and so on and so on, but it is *not* beautiful !...I am sending you a parcel of snails that you may see the sort of thing.

In one beech wood, on the trunks of the trees, we collected rather more than 3000 snails, most of them *Clausilia biplicata* and *C. laminata* (see the parcel), but some *Helix lapidicida.* There are certainly one thousand each of the two *Clausilia* species from this locality, and four or five hundred of each from another wood."

Then follow pages of minute description of each type of shell in the parcel and discussion as to the possibility, by grinding or by taking a melted paraffin cast of the inside, of measuring biometrically this or that character.

"I fancy want of moisture must have more to do with the absence of snails about you than want of chalk. What are you on ? Surely you have nearly the same Oolites and Lias that we have here ?...... Have you committed the sin of digging up a bit of your moor, and looking among roots ?" [Oxford, 13/9/1900.]

"A happy New Year to you ! I send in another envelope specimens of the problematic snail, which has been found in sufficient numbers already. The pattern cannot, I think, be treated as due to lines of growth, and I hope it will be possible to find some way of estimating its variability.—It occurs more or less in a whole series of species here, and here only; and the hills here are so separated by deep valleys, with great climatic differences at different elevations, that there are well isolated local races.

It is rather hard for me to collect many races, because I have to look after my sick laboratory boy, and to teach him sea work, which takes time and produces only isolated examples of pretty museum things, which are a joy to see, although they teach one very little*. To do this and also to find time for a 2000 or 3000 feet climb after snails makes a very good day, and one goes to bed very fit, and full of beautiful remembrances. As one walks up hill, the impression is very absurd. Here the garden is full of bananas and sugar canes ; in an hour's climb one gets into a wood of pine trees and heather, and looks down on to all this tropical valley. The contrast is very curious, and I have not got accustomed to it.

It seems rather a bad year for land beasts. The normal rainfall in December and January is said to be about thirty inches ; and this year practically no rain has fallen since the spring. I suppose as a result of this every live thing gets under the biggest block of basalt it can find. This makes snail hunting rather exciting, because when you get to the top of a kopje where the beasts are you find the sides so steep that any stone you disturb rolls down, unless you take great care. My first day's hunt resulted in such a roll. A stone which I could only just lift rolled down into a sugar cane bed some three or four hundred feet below. I have never felt so ill as I felt until I found that stone and made sure that it had not smashed up an innocent Portuguese peasant !

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* One of the blows to Weldon, which resulted from his biometric view of life, was that his biological friends could not appreciate his new enthusiasms. They could not understand how the Museum "specimen" was in the future to be replaced by the "sample" of 500 to 1000 individuals, not to be looked at through a glass, but to be handled, used, and if necessary *used up.* They warned his pupils solemnly to give up this sort of fooling and take to the real business of the "biologer," if they wished for success. "I told —— about these snails," Weldon wrote on Oct. 11, 1900, "and he wrote me an earnest letter, urging me to return to the pleasant way of describing beasts for the delight of the faithful. That is the real thing if you want to be popular. Go to sea, and have a good time, and bring back a jelly fish which is bright blue."

There is much missionary work yet to be done by biometricians, and Weldon's loss will make it still harder !

If one knew anything about natural history one might do a great service to these people. The whole place is covered with the tracks of a little black ant, introduced with some South American sugar canes five or six years ago. The ant cultivates a number of aphides, which produce serious diseases on all the fruit trees; also it attacks the newly hatched birds and all beasts which shelter under stones. Under a big stone, where some dozen snails have sheltered, about half the shells (which look quite fresh) are eaten empty by ants; so it is with the beetles, grasshoppers, and other things. The only good thing they have done is to eat the cockroaches. Every kitchen is now full of ants, and contains no cockroaches at all.

How snails make their shells here is hard to understand; there is not a scrap of limestone in the place: all basalt and beds of gorgeously coloured volcanic sands. Yet when one finds the right place, one finds that snails swarm and their shells are rather harder than usual!

I should very much like to know whether the habit of hiding under stones is as general in all seasons as it is now. You know Wallace points out that most of the beetles here have lost their wings; and he regards it as probable that flying beetles would be blown out to sea in storms. Now first of all there are practically no storms, and secondly, if there were, the valleys are so deep and their sides so precipitous, that there is abundant shelter against winds. But the loss of wings might well be correlated with the habit of walking under stones to get out of the sun. You find a patch of bare hot sand, so steep that you can hardly stand on it, with a stone here and there, and no sign of any living thing. If you turn over a stone you find a number of snails, a lizard, twenty or thirty beetles, a grasshopper or two, and armies of millipedes....... The man we see most of in this inn is a splendid creature. A captain in the Canadian frontier police, who volunteered for service in South Africa, and is recovering from a bullet through his right lung. Because he has a colonial accent, —— cannot see any merit in him....... It is only another sample of the difficulty I feel every day at Oxford. The boys there are so occupied with silly superficial things that one can never bring them to think of fundamental matters."

[Funchal, 29/12/00.]

"I am glad you are disgusted with the Life. I was afraid you were not.—You cannot judge the man from the bits of his letters. I do not think one ought to try to have an opinion about a man's conduct towards his wife, or indeed about his ethical value at all. One cannot possibly get hold of evidence enough, and the little bits of bad journalism which people give one are only sufficient to disturb one's mind. Take the old man as one knows him by his work, without troubling to guess at his motives, and there is not much the matter with him. I quite agree with you in loving Darwin and —— more; but a man may be a great deal lower than these two, and yet be high enough for reverence." [Oxford, 2/12/00.]

The earlier part of 1901 was chiefly occupied by snails, but a new factor had come into Weldon's many-sided occupations. It was settled that *Biometrika* should have in an early number a critical bibliography of papers dealing with statistical biology. Weldon undertook this task as his study of Mendel had led him to a very great number of such papers dealing with inheritance, and the section on Heredity was to be published first. Like all Weldon's projects, it was to be done in so thorough and comprehensive a manner that years were required for its completion. A very full list of titles was formed, especially in the Inheritance section, and many of the papers therein were thoroughly studied and abstracted (26). But such study meant with Weldon not only grasping the writer's conclusions, but testing his arithmetic and weighing his logic. Thus Weldon's Note on "Change in Organic Correlation of *Ficaria ranunculoides* during the Flowering Season" (27) arose from this bibliographical work and the erroneous manner in which he found Verschaffelt and MacLeod dealing with correlation. A further result of this work was that his confidence in the generality of the Mendelian hypotheses was much shaken. He found that Mendel's views were not consonant with the results formulated in a number of papers he had been led to abstract, and that the definite categories used by some Mendelian writers did not correspond to really well-defined classes in the characters themselves. It was a certain looseness of logic, a want of clear definition and scale, an absence of any insight into how far the numbers reached really prove what they are stated to prove, that moved Weldon when he came to deal with Mendelian work. And his attitude has been largely justified. The simplicity of Mendel's Mendelism has been gradually replaced by a complexity as great as that of any description hitherto suggested of hereditary relationships. This complexity allows of far greater elasticity in the deduction of statistical ratios, but the man in the street can no longer express a judgment upon whether the theory really accounts for the facts, and the actual statistical testing of the numbers obtained, as well as the logical development of the theory, will soon be feasible only to mathematical power of a high order. The old categories are, as Weldon indicated, being found insufficient, narrower classifications are being taken, and irregular dominance, imperfect recessiveness, the correlation of attributes, the latency of ancestral characters, and more complex determinantal theories are becoming the order of the day. If Weldon's papers "Mendel's Laws of Alternative Inheritance in Peas" (28), "On the Ambiguity of Mendel's Categories" (29), and "Mr Bateson's Revisions of Mendel's Theory of Heredity" (30), be read with a due regard to the dates of their appearance, it will be seen that they served, and that they continue to serve, a very useful purpose: they enforce the need for more cautious statement, for more careful classification, and for greater acquaintance with the nature of the inferences which are logically, i.e. mathematically, justifiable on the basis of given statistical data. The need will become the more urgent if the complexity of Mendelian formulae increases at the present rate.

To those who accept the biometric standpoint, that in the main evolution has not taken place by leaps, but by continuous selection of the favourable variation from the distribution of the offspring round the ancestrally fixed type, each selection modifying *pro rata* that type, there must be a manifest want in Mendelian theories of inheritance. Reproduction from this standpoint can only shake the kaleidoscope of existing alternatives; it can bring nothing new into the field. To complete a Mendelian theory we must apparently associate it for the purposes of evolution with some hypothesis of "mutations." The chief upholder of such an hypothesis has been de Vries, and Weldon's article on "Professor de Vries on the Origin of Species" (32) was the outcome of his consideration of this matter. During the years 1902 to 1903 an elaborate attempt was made to grow the numerous sub-races of *Draba verna*, with the idea that they might throw light on mutations. The project failed, largely owing to difficulties in the artificial cultivation of some of the species. But for a time all other interests paled before *Draba verna*.

"Where are you going at Easter? Stone wall country is very good, and if you find a place with delightful old stone villages and pretty churches, *Draba verna* will be there! Come into this region, with the bike, and learn to know and love the dear Dog ![*] Also explain to me how without thrashing to teach that same animal that lambs are not made to be eaten by puppies. There must be a way. I have taught him to walk at heel past the most tempting of other dogs, and even past chickens, and I have not yet beaten him at all. Cows and sheep will I suppose make one or two beatings necessary ?" [Oxford, 7/2/02.]

And a little later comes a letter which shall be cited because it may induce another to take up a form of biometric work, which must some day be pushed to a successful issue ; in the fifteen years of letters there are many problems like this of *Draba verna*, which are discussed month after month with specimens, drawings, and tables, some merely schemed, but in surprising detail, others reaching the experimental stage, some in part solved, others but records of failure, one and all suggestive.

"*Draba verna*, or its earliest race is in full flower. I have four model types from a certain wall.

Now can you and Mrs Pearson give us the week end, so that your eyes may see the glory of this plant ?

If you can turn up on Friday (I finish lecturing at 6) we can go for a tramp on Saturday, and see *Draba* at home on its walls. A gentle 7 or 8 miles all told, in a decently pretty country, with a variable plant in the middle and a really Perfect Dog all the way makes a very good combination ;—only bring some knickerbockers, because Oxford Clay goes over one's ankles in places just now.

We can bring home our spoil, and discuss the very difficult question of descriptive units.

I think it a good and important thing to try. All the problems of treating mixed races come in ; and above all I am curious to see what comes of statistical treatment applied to characters which have been chosen by "naturalists." They all say we choose anything which is easy to measure, and neglect the real points of "biological" importance ; and there is a little truth in this reproach.

For *Draba* we want units of "habit," of shape and colour of leaves, of hairiness, of shape and colour of petals, sepals and fruit. We want to treat leaves which are very distinctly differentiated according to their relative time of appearance, and I think having tabulated all these characters, we want to break up the plants on a wall which you shall see on Saturday into about four races.

Do come if you possibly can. I saw one plant yesterday with all its seed capsules ripe and open ; so that the first lot of little races will very soon be out of flower.

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[*] The great Borzoi Sandro, henceforward to be a marked feature of the Weldon household, at home and away from home. Sandro pursuing sheep over the Yorkshire moors, Sandro pursuing game in the Buckinghamshire beechwoods, Weldon pursuing Sandro with every tone of affectionate persuasion, on the track the stacked cycles and the co-editor pursuing the deserted biometric problems in solitude, Weldon returning with the unchastised dog, after any interval of from 10 to 40 minutes, the chase being fully completed, the apologies for the Borzoi, his sustentation on chocolate and the human need for cigarettes, the return to the cycles, to the experiment that was to be crucial, to the colour and the sunset, these are all memories, the like of which others will have shared, which helped to form the atmosphere about the man. Sandro achieved his purpose, he kept his master out in the air—such wolf hounds can follow a cycle for miles—and to exercise him was held up as a moral duty. But his limited intelligence led to his own disablement and he had to become a partaker only in biometric "at homes." For two years, however, he was a great feature of our joint expeditions.

As *Nebensachen*, there are the mice and I very much want you to group the snails* in your own way—to see how far your grouping will bring them into a better form for the curve!

But *Draba verna* ought to be an example of the whole bearing of statistical methods upon systematic problems. I think it is rather important to begin this spring by collecting material for an analysis of the races round here, and a comparison of these with the types recognised by systematists. Learning these and their variability in this neighbourhood this spring, we can learn cotyledon characters and the characters of the first formed leaves in the Autumn—basing upon these a first set of hereditary correlations.

Again, the statement that each of Jordan's species can be recognised *at any stage in the life-history of the plant* makes it necessary to work correlations between cotyledon characters, autumn leaf characters, and spring characters. All this is work for lots of folk, and it is most important to get it properly planned now. Therefore, and for lots of other reasons try to come on Friday!

The Dog shall be washed for you!" [Oxford, 22/2/02.]

The reference in this letter to the mice indicates that that great piece of experimental work in heredity was now started. A study of the work of von Guaita had convinced Weldon early in 1901 that the cross between the European albino mouse and the Japanese waltzing mouse was not one which admitted of simple Mendelian description. In May, 1901, his letters contain inquiries as to Japanese mice dealers. During the summer and autumn the collection of Japanese mice was in progress. These mice were to be bred to test the purity of the stock; during December about forty does had litters, and pure breeding went on until the autumn of 1902, when hybridisation commenced. The work on these mice was for two years entrusted to Mr A. D. Darbishire, but the whole plan of the experiments, the preparation of the correlation tables, and the elaborate calculations were in the main due to Weldon. On Mr Darbishire's leaving Oxford, Weldon again resumed personal control of the actual breeding arrangements, and from second hybrid matings carried on the work to the sixth hybrids' offspring. The work was nearing completion at his death, and through the energy of Mr Frank Sherlock the skins of the 600 pedigree mice forming the stud at that time have been dressed and added to those of the earlier generations. The reduction and publication of this material will, it is hoped, be not long delayed (33). Weldon had this work much at heart, and his letters during 1904 and 1905 give many indications of the points he considered demonstrated. The experimental part of the work would have been nearly completed had not his whole thought and energy been directed from November, 1905, into another channel.

From 1901 it is harder for the present writer to give a detailed account of Weldon's life, the co-editorship of *Biometrika* and common work brought them so continually into contact. In the early part of the summer there had been a hurried visit to Gremsmühlen for young *Clausilia*; Weldon on his return visited his co-editor at Througham in Gloucestershire bringing his Brunsviga†, and there was calculation and reduction of *Clausilia* data. Later there was a hurried visit to the Tegernsee and to Munich for opera. At Easter, 1902, there was a noble missionary effort (with the Brunsviga) to Parma; the missionary carried a memoir, which he had spent some weeks in rewriting in biometric form, but his efforts to show that a science of statistics exists were unavailing. In the summer *Biometrika* was edited from Bainbridge in Wensleydale, and accompanied by Sandro, the co-editors cycled to the churchyards of the Yorkshire dales, collecting material for their joint paper "On Assortative Mating in Man" (34). From Bainbridge the Weldons went to the British Association meeting at Belfast, where an evening lecture on Inheritance was given. At Christmas came one of the above-mentioned visits to Palermo to collect Sicilian snails. An event of this year (1902) was the publication of Mr Bateson's *Mendel's Principles of Heredity.* The origin of Weldon's first paper on Mendel has been described in this memoir; it was an expansion of a part of the promised bibliography for this Journal, and was written without any *arrière pensée* or knowledge of Mr Bateson's not then published experimental work. It is impossible for one who has been and again may be a combatant in this field to say more than that the tone of Mr Bateson's defence deeply pained Weldon, and rendered it difficult for a finely strung temperament to maintain—as it did maintain to the end—the impersonal tone of scientific controversy.

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* *H. nemoralis* and *H. hortensis* of which many hundreds had now been collected from various parts of England by Weldon and his helpers.

† The familiar mechanical calculator of the biometrician, the grinding sound of which (emphasised by the want of oiling in Weldon's case!) is the music which tells him how much his labours can be lightened.

In the spring of 1903 Weldon was busy, as were the whole available members of the biometric school, in studying the influence of environment and of period of season on the variation and correlation of the floral parts of Lesser Celandine.

> "Give my love to the Brethren who are cooperating in the matter of Celandines, and beseech them to make a better map of their country than the enclosed." [Oxford, 23/2/03.]

Weldon threw his whole energy and love of minute exactitude into the task, and his letters are filled with an account of the almost daily changes in the type and variability of the Celandine flowers from his selected stations. The result of this enquiry was the collection of an immense amount of data showing that environment and period in the flowering season affected the flower characters to an extent comparable with the differences attributed to local races. The reduction of the material has gone on progressively, if intermittently since, and it is hoped that a memoir, which will be a sequel to that issued in *Biometrika**, may be published shortly (35). The wider standpoint of this second memoir will be chiefly due to Weldon's initiative and critical mind. At Easter of 1903 a series of mishaps prevented the common holiday, but this was more than compensated for by the summer vacation. The Weldons started with a sea trip to Marseilles and back. They then returned to Oxford, that work on the article *Crustacea* for the Cambridge Natural History might be carried on, and an eye kept on the mice. But a biometric camp was formed at Peppard on the Chilterns; here the "Consulting Editor" and one of the co-editors had established themselves, and the Weldons took a week-end cottage. The three Oxford members of the party arrived partly on cycles and partly on four feet, and were often met *en route* by the residents in the uplands, the numbers being swelled by the addition of biometricians from the London or Oxford schools. Hence arose a series of Friday "biometric teas," for the discussion of the week's work and plans for the next two days. Saturday and Sunday morning were given to steady calculating and reducing work, and much was got through. The data on assortative mating in man collected in the previous year were reduced and a joint paper sent to press; the immense amount of calculation and reduction involved in the mouse-paper was got through; a joint criticism of Johannsen's *Ueber Erblichheit in Populationen und in reinen Linien* was written by the co-editors under the title "Inheritance in *Phaseolus vulgaris*" (36); the Huxley Lecture was written with yeoman help from the Oxford contingent, and lastly, a joint study was made, at Weldon's suggestion, of the relationship between Mendelian formulae and the theory of ancestral heredity. It was shown that there was no essential antagonism between the two methods of approaching the subject, and the results were published ultimately as Part XII of the *Mathematical Contributions to the Theory of Evolution*, Weldon persistently declining to allow it to appear as a joint memoir, because he had taken no part in certain portions of the more complicated algebraic analysis. Christmas found two-thirds of the party reunited in Palermo, and Weldon on the snail quest. His letters thence to his co-editor teem with the freshness of the sky and the joy of open-air work:

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* Vol. II. pp. 145—164, *Cooperative Investigations on Plants.* II. Variation and Correlation in Lesser Celandine from Divers Localities.

> "Out between five and six, in the dark, without any breakfast, sunrise up in the hills, a day's tramp on a piece of bread and a handful of olives, and home at seven, laden with snails. Then after dinner to clean the beasts. That is not work, and it makes one very fit, but one gets tired enough to sleep when the snails are cleaned!
>
> The camera works all right, and I think there is a very marked correlation between the general character of the limestones and the character of the shells; but developing in one's bedroom does not make for negatives which will "process"! Also it involves heavy subsidies to such chambermaids as do not understand what new form of madness this particular foreigner has developed!
>
> I have repeated all last year's collections, and have tried hard to get a series of forms, such as Kobelt describes, intermediate between the rounded and the flat keeled forms, but I cannot at present find these. They ought (according to him) to live in a certain wilderness of beautiful mountains twenty miles away. I have several times tramped without any result. I hope to try again. I feel sure something worth having will come out of these shells; they illustrate local races and the general problem of what is a species splendidly. But the question of their markings comes in also; and you, or Galton, or someone, will have to make a scale of patterns for me, I expect. They will be the most perfectly hopeless things to draw!
>
> It is, of course, just conceivable that the intermediate, slightly keeled forms described in 1879 by Kobelt have been exterminated since his time? He is very precise in his localities, and everywhere except in his transitional region I find *exactly* what he describes, but in this region I find so far only rounded forms.
>
> The only difficulties about tramping in this country are the *carabinieri.* Every high road is patrolled by groups of two or three, so that even in a desolate place, so long as you keep to the road, you are rarely out of rifle shot; but these men come and solemnly warn you that the people round are ruffians, who would cheerfully cut your throat for a soldo; and if you simply grin, they make a great pretence of falling in behind you and guarding you.... Now collecting snails with an armed guard becomes ridiculous after a time and there is no danger at all; the

men only want tips. When one gets off the road into the hills the goatherds and other ruffians are most friendly. They want to see one's camera, and one's knife, and of course they want half one's bread, but they never ask for tips, and my throat is still uncut.

We have so far had two wet days; to-day, and one other.—We have had several inches to-day, and shall have some more; but between we have had the most glorious sun. I look as if I washed in strong coffee every morning." [Palermo, 31/12/1903.]

At the beginning of 1904 the work on the Brescia *Clausilia* was in progress, the mice were multiplying after their kind and Weldon's thoughts were turning more and more to a determinantal theory of inheritance, which should give simple Mendelism at one end of the range and blended inheritance at the other. Easter was spent in common, one editor at Rotherfield Greys and the other at Peppard, with the usual flow of suggestion on Weldon's part and the bi-weekly cyclings to Oxford to look after the mice. Now and then the fear would strike Weldon's friends that life was being lived at too fast a pace, but the constant intellectual and physical activity was so characteristic of the man that there was no means of calling halt, and to many when Weldon was most active he seemed most fit and well. The summer found the Pearsons twelve miles from Oxford, at Cogges, near Witney, and the Galtons twenty miles further, at Bibury; there was much cycling too and fro, and the plan of a new book by Weldon on Inheritance was drafted, and some of the early chapters written. The vacation was broken by the visit to Cambridge—Weldon cycling in one day from Oxford—for the British Association. The Presidential Address in the Zoological Section was chiefly an attack upon biometric work and methods, and the discussion which followed culminated in the President dramatically holding aloft the volumes of this Journal as patent evidence of the folly of the school, and refusing the offer of a truce to this time-wasting controversy. The excitement of the meeting, as earlier contests at the Zoological and Linnean Societies, seemed to brace Weldon to greater intellectual activity and wider plans, but the torpedo boat was being run at full speed.

The book on Inheritance occupied most of the remainder of the year, and to aid it forward and help those of us who were not biologists to clearer notions, I suggested to Weldon a course of lectures in London to my own little group of biometric workers. The project grew, other departments of the College desired to attend, and ultimately the lectures were thrown open to all members of the University and even to the outside public. Weldon had a good audience of more than a hundred, and enjoyed the return to his old environment. But it may be doubted whether his vitality responded as quickly as of old to the additional stress; there were special elements of difficulty, and I believe now that it would have been kinder and more helpful had we limited the audience to my own small body of sympathetic students.

"It will be a great pleasure to me to come and talk, and to feel that you cared to ask me; the lectures will do far more good to me than to anyone else ... and I owe U. C. L. a bigger effort than this anyhow." [Oxford, 16/10/04.]

And again:

"It makes me more than ever glad I am coming back to Gower Street where there are live people to talk to! Surely thirty people* is a great many. Try talking for five years to an audience of from three to nine, and see how the thought of thirty will cheer you! And none of these excellent folk are sent by their tutors!" [Oxford, 7/11/04.]

The letters of Weldon to both Francis Galton and myself during the years 1904 and 1905 are full of inheritance work, the details of the great mice-breeding experiment, the statement and the solution, or it might be the suggested solution, of nuclear problems leading to determinantal theories of inheritance. Occasionally there would be a touch of conscience, and the drawings for the *Crustacea* would be pressed forward:

"I ought to give my whole time to the Cambridge Natural History for a while. They have been very good to me, and I have treated them more than a little badly. I am rather anxious to get them off my conscience." [Oxford, 15/2/05.]

But only the chapter on *Phyllopods* got completed, figures and all, and set up. Many figures were prepared for other parts; beautiful things, which gave Weldon not only scientific but artistic pleasure, he had made, but the text remains the veriest fragment. In the same way but little was absolutely completed of the article on *Heliozoa* for Lankester's *Natural History*. It was not Weldon's biometric friends that kept him from these tasks, it was solely his own intense keenness in the pursuit of new knowledge. It was occasionally with a feeling of great responsibility that the present writer would propound to him an unsolved problem with which he might himself be struggling. There was absolute certainty that if the problem was at all an exciting one, Weldon would leave his scent and follow the new trail with his whole keenness and at full speed. All else would be put on one side, and he could only be recalled to natural history or biometrics by an appeal to his conscience. Like Sandro, the chase must be completed before he returned to the humdrum trot behind a cycle on the highway.

The fascination of inheritance problems kept Weldon, however, for months at a time at the Heredity Book. At Easter, 1905, he went to Ferrara†, because that place had a university, and as such must have a library, where work could be done. The contents of the library were perfectly mediaeval, a characteristic appropriate in the castle, but hardly helpful in heredity‡. Still, portions of the manuscript came to England for comment and criticism, and we were hopeful that the end of the year would see the book completed.

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* The number I already knew would certainly attend.

† "The town is worth a lot, and the fields are full of a little speedwell, which varies most delightfully. I have so far resisted the temptation to chuck the wretched book and tabulate the variations of its flowers, and I hope I shall do to the end. But it is a temptation......I feel out of the world, an absolute blank, with only a slight interest in newts' tails and an even slighter in a statue of Savonarola which looks at me all day through the window." [Ferrara, 3/4/05.]

‡ From Ferrara came back if not the speedwells, masses of silkworms' eggs of different local races, but providentially they failed to hatch out in sufficient numbers owing to the May frosts and no new scent took Weldon off the book and the mice during the summer.

It must not be thought for a moment that Weldon was desultory in his work. As E. R. Lankester says in a letter to the writer: "His *absolute thoroughness* and unstinting devotion to any work he took up were leading features in his character." He pursued science, however, for sheer love of it, and he would have continued to do so had he been Alexander Selkirk on the island with no opportunity for publication and nobody to communicate his results to. He never slackened in the total energy he gave to scientific work, but having satisfied *himself* in one quest, he did not stay to fill in the page for others to read; his keen eye found a new problem where the ordinary man saw a cow-pasture, or a dusty hedgerow, and he started again with unremitted ardour to what had for himself the greater interest. The publication of his researches will show that it is not we who are the losers, because he went forward, regardless of publication and finality of form. The true function of such a man is not to write text-books or publish treatises, it lies in directing and inspiring a school, which will be trained by completing the work and carrying out the suggestions of its master. The curse of the English educational system is that it leaves such men to solitude, and throngs the chambers of those who cram all nature into the limits of the examination room.

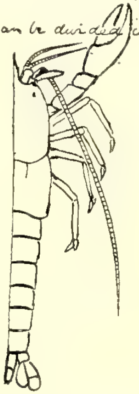
In the summer the present writer was at East Ilsley, some seventeen miles from Oxford, and there was cycling out several times a week; the writer's chief work was on other than biometric lines and broken by other claims on his time, but there was steady joint work on the determinantal theory of inheritance as outlined by Weldon, and it is hoped that it is sufficiently advanced to be completed and published (37). Weldon had in August, 1905, given to the Summer Meeting of the University Extension in Oxford a lecture on *Inheritance in Animals and Plants* (38), and this had taken up some of his energy during the summer vacation. On the whole, however, he worked persistently at the Inheritance Book. It is too early yet to say definitely how far it can be considered ready for press, but a considerable number of chapters are completely ready, and there are drafts for several others. We can only hope that this, the work he was in many respects best fitted for both by direct experiment and by study of the labours of others, will be issued in his name and show the full measure of his activities during these last few years.

It cannot be denied that those who were often with Weldon during the last two years were occasionally anxious—the pace had been too great—but at no time had one definitely realised that there was an immediate anxiety. His intellectual activity was never apparently diminished, and his long cycling rides were maintained to the end. It was an occasional, but never long persistent, lack of the old joyousness in life which was noticeable. At East Ilsley he was full of keenness over his photographic work; he enjoyed an antiquarian investigation into the probable final *locus* of the bones of St Birinus with a view to testing a local legend; we examined carefully a human skeleton dug up from under a sheepfold, the authorities having determined that no inquest was needful, the bones being those of an old man who died "hundreds of years ago." "And you think?" said

To the Editor of Biochronicle

Sir, — In the last number of your most instructive Journal you publish an account of the way in which Snails are collected by the energetic naturalists of Brush. It may ~~bring~~ interest to some of your numerous readers to follow up the thoughts suggested by this account, and to know something of the way in which snails grow up before they are collected.

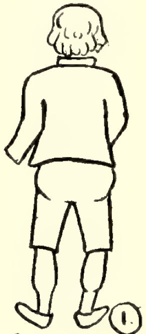
As you, Sir, know very well, a snail is unlike most of the animals found in the neighbourhood of Brush, in its shape. ~~And~~ Most of the animals in the Brush collection, whether Bats, or Butterflies, or Crayfishes, or others, can be divided into two halves, which are curiously alike. If you take a thing like the drawing in the margin, which is meant to be like half a cray-fish, and put the straight edge of the drawing against a looking glass, the reflection of this drawing in the glass will be very like the other half of the crayfish. All the legs of a crayfish are in pairs, so that there are right and left legs, as curiously like each other as ~~the hands~~ your Editorial Hands are like each other.



But except the two halves of its brain, and its eyes, and one or two other organs on its head, the parts of a grown up snail are not arranged in pairs in this way. When a snail is quite young, inside its egg-shell, you can recognise a right and a left half of it, just as you can in a cray-fish; but as it grows up, its left hand side grows very much faster than its right hand side, so that the right-hand side nearly disappears. I would ask you to consider, Sir, what the effect of such a mode of growth would be upon your Editorial Self; and I trust you will not think me wanting in respect if I submit for your consideration a few diagrams indicating the effect of this upon your person.

You see that the effect would be to make your legs point forwards, towards your head, and to make the leg which is now on your right side look as if it belonged to your left side, or at least to make it lie to the left of the other leg.

In the region of your waistcoat you would have a most uncomfortable swelling, which I apologise for suggesting.



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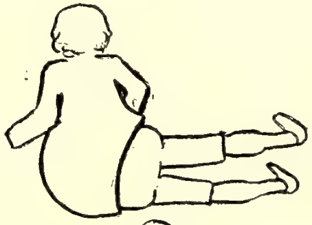

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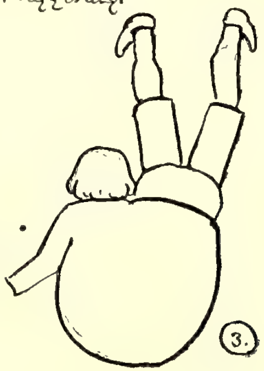
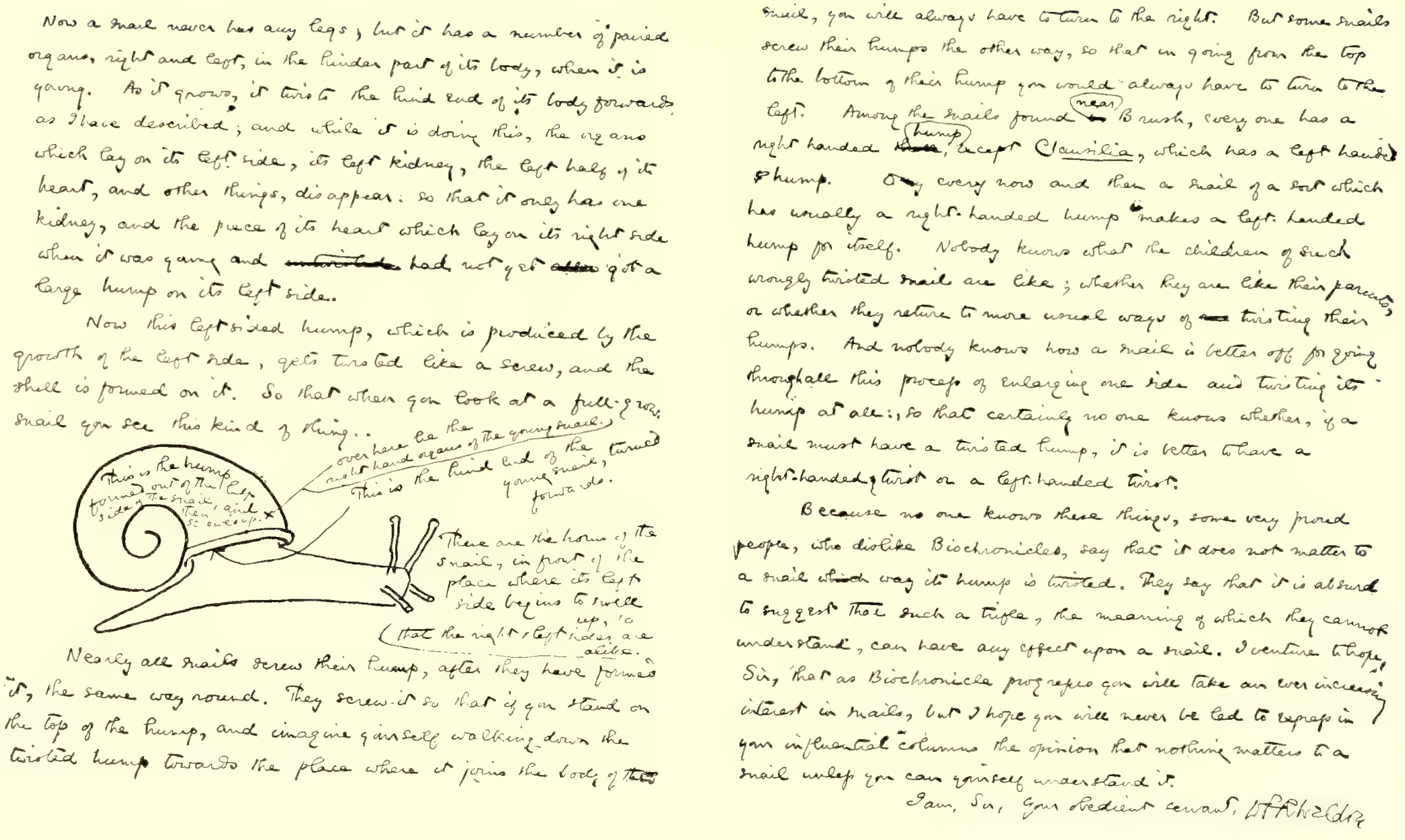


3.

Plate V.



Now a snail never has any legs, but it has a number of paired organs, right and left, in the hinder part of its body, when it is young. As it grows, it twists the hind end of its body forwards, as I have described; and while it is doing this, the organs which lay on its left side, its left kidney, the left half of its heart, and other things, disappear: so that it only has one kidney, and the piece of its heart which lay on its right side when it was young and ~~[illegible]~~ had not yet ~~[illegible]~~ got a large hump on its left side.

Now this left sided hump, which is produced by the growth of the left side, gets twisted like a screw, and the shell is formed on it. So that when you look at a full-grown snail you see this kind of thing..

This is the hump formed out of the left side of the snail, and then screwed up. ×

over here lie the right hand organs of the young snail.

This is the hind end of the young snail, turned forwards.

There are the horns of the snail, in front of the place where its left side begins to swell up, so that the right & left sides are alike.

Nearly all snails screw their hump, after they have formed it, the same way round. They screw it so that if you stand on the top of the hump, and imagine yourself walking down the twisted hump towards the place where it joins the body of the snail, you will always have to turn to the right. But some snails screw their humps the other way, so that in going from the top to the bottom of their hump you would always have to turn to the left. Among the snails found ~~in~~ near Brush, every one has a right handed ~~[illegible]~~ hump, except Clausilia, which has a left handed ~~[illegible]~~ hump. O~~nl~~y every now and then a snail of a sort which has usually a right-handed hump makes a left-handed hump for itself. Nobody knows what the children of such wrongly twisted snails are like; whether they are like their parents, or whether they return to more usual ways of ~~[illegible]~~ twisting their humps. And nobody knows how a snail is better off for going through all this process of enlarging one side and twisting its hump at all; so that certainly no one knows whether, if a snail must have a twisted hump, it is better to have a right-handed twist or a left-handed twist.

Because no one knows these things, some very proud people, who dislike Biochronicles, say that it does not matter to a snail wh~~ich~~ way its hump is twisted. They say that it is absurd to suggest that such a trifle, the meaning of which they cannot understand, can have any effect upon a snail. I venture to hope, Sir, that as Biochronicle progresses you will take an ever increasing interest in snails, but I hope you will never be led to express in your influential columns the opinion that nothing matters to a snail unless you can yourself understand it.

I am, Sir, Your obedient servant, W F R Weldon

Weldon on our homeward way. "Having no anatomical training I think they are those of ——." "A young woman, who has not been buried so very long," he interrupted, with a responsive twinkle in his eye. "Let us have a smoke and consider the scientific education of the English medical profession." His sense of humour was always keen, whether with word or pencil, and it remained with him to the end. The joy of life which in the early days led him to dance and sing on the completion of a heavy bit of work, made him in later manhood ripple over with quiet humour in talk and letter when problems were going well.

Thus to Francis Galton:

> "I enclose the best I can do with one of the negatives you were kind enough to let me make. Please forgive me for caricaturing you in this way.—You know enough about the lower forms of man to know that respect and affection show themselves in strange ways:—look upon this as one of them and pardon it." [Oxford, 27/7/05.]

Nor did he spare a quiet joke at a friend:

> "Your work on dams has filled the Italian papers with horror. They say you threaten the safety of all existing dams, *however long they have stood.*" [Ferrara, 7/4/05.]

In November, 1905, Weldon was unfortunately taken off from the work on his inheritance book by the presentation to the Royal Society of a paper by Captain C. C. Hurst: *On the Inheritance of Coat-Colour in Horses.* He had had no proper summer holiday, but he threw himself nine hours a day into the study of *The General Studbook*.*

> "I can do nothing else until I have found out what it means....The question between Mendel and Galton's theory of Reversion ought to be answered out of these. Thank God, I have not finished that book. There must be a chapter on Race Horses!"

Weldon felt himself in a difficult position; as Chairman of the Zoological Committee, he had at once directed the printing of Hurst's paper. But the subject being one in which he personally was keenly interested, he had immediately attacked the original material and to his surprise came to views definitely opposite to those of Hurst. He felt bound to report this result at once to the Society, and he did so on December 7, when the original paper was read. His results were provisional, as could only be the case considering the short period of preparation that had been possible. He promised to communicate a note to the Society involving more details of his inquiry. This was done on January 18, 1906 in a "Note on the Offspring of Thoroughbred Chestnut Mares" (39).

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* I cannot resist citing a last illustration of Weldon's humour: "What volumes of Weatherby have you? I have found in Bodley 17—20. To show you what Bodley is, I looked in the catalogue vainly under: *Weatherby* (found here and not under Racing, *Racing Calendar*), *Jockey Club* (found here pamphlets about the J. C. but *not* its own publications), *Horses*, *Race Horses*, *Racing*, *Studbooks* (found here only Clydesdale Studbook, Pigeon Studbooks, and Dog Studbooks), *Turf*, *Sport*, *Race*, all suggested by assistants in the Library. For a whole day I raged, and came back despairing. Next day I raged worse, and captured a man who knew something. He smiled and said: 'Oh, Yes, The General Studbook is entered under *General* of course.' I said, 'Why not under *The*?' and he thought that unseemly!"

"The object of the present note is partly to fulfil my promise and partly to call attention to certain facts which must be considered in the attempt to apply any Mendelian formula whatever to the inheritance of coat-colour in race-horses."

It is impossible at present to say more on this point, for the whole subject is likely to be matter for further controversy. Even one authenticated case of a non-chestnut offspring to chestnut parents is sufficient to upset the theory of the 'pure gamete,' but if studbooks are to be taken as providing the data, the whole question must turn on whether one in sixty of the entries of the offspring of chestnut parents can be reasonably considered as a misprint or an error in record.

Here it can only be said that Weldon took up the subject with his usual vigour and thoroughness. But he was overworked and overwrought and a holiday was absolutely needful. He went to Rome, but the volumes of the Studbook went with him:

"Will you think me a brute, if I take the Studbook to Rome? I really want a holiday, but I cannot leave this thing unsettled."

And then from Rome:

"I think it will be worth while to deal for once with a whole population, not with a small random sample. Only I could find it in my heart to wish one need not do it in Rome! To sit here eight hours a day or so, doing mere clerk's work, seems rather waste of life?"

And again:

"I have really been working too hard to write, or to do anything else. I have seen *nothing* of Rome....I want to know what these horses will lead to, but it would not interest me at all to know that my paper on them would or would not be printed. More important is the enormous time these horses will take. It seems clear that one ought to carry these arrays back to another generation of ancestors—and that means a very long job. I wish I had a pupil! A mere clerk would be no good, but a pupil, such as one had in good old Gower Street, would help with the drudgery, and then he might stick his name all over the paper, if he liked."

[February, 1906.]

The letters are filled with Studbook detail till Easter, there is hardly a reference to anything else. Re-reading them now one sees how this drudgery with no proper holiday told on Weldon. Hundreds of pedigrees were formed and a vast amount of material reduced. At Easter the Weldons went to the little inn at Woolstone, at the foot of the White Horse Hill, and his co-editor came down later to Longcot, a mile away, for the joint vacation. Weldon was still hard at work on the Studbooks, but he was intellectually as keenly active as of old; he was planning the lines of his big memoir on coat-colour in horses (40) and showing how they illustrated the points he had already found in the mice. He was photographing the White Horse, and rubbing mediaeval idlers' scrawlings on the church pillars. He projected the despoiling of a barrow, and planned future work and rides.

On Sunday, April 8, he rode into Oxford to develop photographs, and the present writer rode some miles of the way with him; the joint ride terminated with the smoke by the roadside and Weldon's propounding the problem which was to be brought solved for him on Tuesday. On Tuesday I found him in bed, with what appeared to be an attack of influenza. He had expressed himself tired after his ride on Sunday, an almost unique admission. But on Monday he went a long walk over the Downs, getting home late. He came down to breakfast on Tuesday but had to return to bed. In the afternoon when I came he insisted on smoking and wanted the solution of the problem, saying he was better. I begged him, as one still closer did, to stay in bed on the morrow and give up a projected journey to Town. But there was a dentist to be seen, preparations for a visit to the M.B.A. Laboratory at Lowestoft to be made, and a wonderful picture-gallery to be visited to free him from the atmosphere of the Studbooks. His will was indomitable; he went up to Town and went to the pictures on Wednesday, he went to the dentist on Thursday, but from the dentist's chair he had to be taken to a doctor's, and thence to a nursing home. The summoning telegram reached his wife on the same afternoon, and he died of pneumonia on Good Friday, April 13. So passed away, shall I say not unfitly—for it was without any long disabling illness and in full intellectual vigour—a man of unusual personality, one of the most inspiring and loveable of teachers, the least self-regarding and the most helpful of friends, and the most generous of opponents.

As for his life, I think it was to him what he would have wished it. There were moments of discouragement and depression, he felt occasionally a want of sympathy for his life-work in some of his former colleagues, and while he was born to be the centre of an enthusiastic school, he found at times somewhat scanty material for its maintenance in pleasure-loving Oxford. But every stone he lifted from the way became gold in his hands; each problem he touched became a joy which absorbed his whole being. The artist in his nature was so intense that he found keen pleasure in most men and in all things. Only meanness or superficiality fired him, and then, considering how the world is built, sometimes to almost an excess of wrath. But he had no personal hate; he could make the graceful amend, and had he ever a foe, that foe, I veritably believe, could have won Weldon's heart in the smoking of a cigarette.

If we pass from himself to those whose fortune brought them in close contact with him—to his friends and pupils—their loss can only be outlined, it is too intimate and personal for full expression. There was a transition from respect to reverence, a growth from affection to love; to such a tenderness as some bear for a more delicate spiritual nature, to even such feeling as the Sikh is reputed to hold for the white man's child in his charge.

And lastly as to science, what will his place be? The time to judge is not yet. Much of his work has still to be published, and this is not the occasion to indicate what biometry has already achieved. The movement he aided in starting is but in its infancy. It has to fight not for this theory or that, but for a new method and a greater standard of logical exactness in the science of life. To those who condemn it out of hand, or emphasise its slightest slip, we can boldly reply, You simply cannot judge, for you have not the requisite knowledge. To the biometrician, Weldon will remain as the first biologist who, able to make his name by following the old tracks, chose to strike out a new path—and one which carried him far away from his earlier colleagues. It is scarcely to be wondered at if those he joined should wish to see some monument to his memory; for he fell, the volume of life exhausted, fighting for the new learning.

Is what he gave science small? That depends on how it is measured. He was by nature a poet, and these give the best to science, for they give ideas. They follow no men, but give that which another generation may study from and be inspired by. He was the enthusiast, but the enthusiasm was that of the study, trained to its task; and when the time comes that we shall know, or that those who come after us shall know, whether Darwinism is the basal rule of life or merely a golden dream which has led us onwards to greater intellectual insight, then the knowledge, so biometricians have held and still hold, will be won by those actuarial methods which he first applied to the selection of living forms. If there be aught else to be said, let another say it.

> Step to a tune, square chests, erect each head,
> 'Ware the beholders!
> This is our master, famous, calm and dead,
> Borne on our shoulders.

Description of Plates.

Plate I. W. F. R. Weldon.

Plate II. Raphael Weldon, aged 10.

Plate III. (*a*) Rapid pencil caricature by W. F. R. W. "Apparition: Le Café Orleans."

(*b*) Sample of Illustration to letters. Description of bands of *H. hortensis* in letter to a lady collector. "Has it occurred to you that a lady of artistic ability, and so enlightened that she likes snails, would have great joy and do great service by drawing them? There is a good inexorable severity about their lines which one would enjoy, I should think, if it were not so unattainable (to me!) on paper. And it would be nearly as good fun as real engraving to get all their lights and shadows put in with curved lines which also indicate the growth lines on the shell? Think how Bewick liked it."

Plate IV. A "crabbery" at Plymouth.

Plate V. Contribution to a manuscript magazine run by a youthful friend.

LIST OF MEMOIRS, ETC., BY W. F. R. WELDON.

(1) Note on the early Development of *Lacerta muralis*. *Q. Jour. Mic. Sci.* Vol. XXIII, pp. 134—144, 1883.

(2) On the Head-Kidney of *Bdellostoma*, with a suggestion as to the Origin of the Suprarenal Bodies. *Q. Jour. Mic. Sci.* Vol. XXIV, pp. 171—182, 1884.

(3) On the Suprarenal Bodies of Vertebrates. *Q. Jour. Mic. Sci.* Vol. XXV, pp. 137—150, 1885.

(4) On some points in the Anatomy of *Phoenicopterus* and its Allies. *Proc. Zool. Soc. Lond.* 1883, pp. 638—652, 1883.

(5) Note on the Placentation of *Tetraceros quadricornis*. *Proc. Zool. Soc. Lond.* 1884, pp. 2—6, 1884.

(6) Notes on *Callithrix gigot*. *Proc. Zool. Soc. Lond.* 1884, pp. 6—9, 1884.

(7) On *Dinophilus gigas*. *Q. Jour. Mic. Sci.* Vol. XXVII, pp. 109—121, 1886.

(8) *Haplodiscus piger*; a new Pelagic organism from the Bahamas. *Q. Jour. Mic. Sci.* Vol. XXIX, pp. 1—8, 1888.

(9) Preliminary Note on a *Balanoglossus* Larva from the Bahamas. *R. S. Proc.* Vol. XLII, pp. 146—150, 1887.

(10) The Coelom and Nephridia of *Palaemon serratus*. *Journal Marine Biol. Assoc.* Vol. I, pp. 162—168, 1889.

(10) *bis* Note on the Function of the Spines of the Crustacean *Zooea*. *Journal Marine Biol. Assoc.* Vol. I, pp. 169—170, 1889.

(11) The Renal Organs of certain Decapod Crustacea. *Q. Jour. Mic. Sci.* Vol. XXXII, pp. 279—291, 1891.

(12) The Formation of the Germ Layers in *Crangon vulgaris*. *Q. Jour. Mic. Sci.* Vol. XXXIII, pp. 343—363, 1892.

(13) The Variations occurring in certain Decapod Crustacea. I. *Crangon vulgaris*. *R. S. Proc.* Vol. XLVII, pp. 445—453, 1890.

(14) Certain correlated Variations in *Crangon vulgaris*. *R. S. Proc.* Vol. LI, pp. 2—21, 1892.

(15) On certain correlated Variations in *Carcinus moenas*. *R. S. Proc.* Vol. LIV, pp. 318—329, 1893.

(16) [On Variation in the Herring. Unpublished measurements and reductions presented to the Evolution Committee.]

(17) Attempt to measure the Death-rate due to the Selective Destruction of *Carcinus moenas* with respect to a Particular Dimension. Report of the Committee...for conducting Statistical Inquiries into the Measurable Characteristics of Plants and Animals. *R. S. Proc.* Vol. LVII, pp. 360—379, 1895.

(18) Remarks on Variation in Animals and Plants. *R. S. Proc.* Vol. LVII, pp. 379—382, 1895.

(19) [Report to the Evolution Committee on the Growth of *Carcinus moenas* at successive moults. 1897. Unpublished.]

(20) Presidential Address to the Zoological Section of the British Association. *B. A. Transactions*, Bristol, 1898, pp. 887—902.

(21) [Researches on Pedigree Moths, 1899-1901. Unpublished.]

(22) Cooperative Investigations on Plants. I. On Inheritance in the Shirley Poppy. *Biometrika*, Vol. II, pp. 56—100, 1902. [A joint paper with others.]

(23) A First Study of Natural Selection in *Clausilia laminata* (Montagu). *Biometrika*, Vol. I, pp. 109—124, 1901.

(24) Note on a Race of *Clausilia itala* (von Martens). *Biometrika*, Vol. III, pp. 299—307, 1903.

(25) The Scope of *Biometrika*. Editorial. *Biometrika*, Vol. I, pp. 1, 2, 1901.

(26) [Critical Bibliography of Memoirs on Inheritance. Unpublished.]
(27) Change in Organic Correlation of *Ficaria ranunculoides* during the Flowering Season. *Biometrika*, Vol. I, pp. 125—8, 1901.
(28) Mendel's Laws of Alternative Inheritance in Peas. *Biometrika*, Vol. I, pp. 228—254, 1902.
(29) On the Ambiguity of Mendel's Categories. *Biometrika*, Vol. II, pp. 44—55, 1902.
(30) Mr Bateson's Revisions of Mendel's Theory of Heredity. *Biometrika*, Vol. II, pp. 286—298, 1903.
(30) *bis* Mendelism and Mice. *Nature*, Vol. LXVII, pp. 512, 610, Vol. LXVIII, p. 34, 1903.
(31) Albinism in Sicily and Mendel's Laws. *Biometrika*, Vol. III, pp. 107—109, 1904.
(32) Professor de Vries on the Origin of Species. *Biometrika*, Vol. I, pp. 365—374, 1902.
(33) [On the Results of Crossing Japanese Waltzing with Albino Mice. Unpublished.]
(34) On Assortative Mating in Man. *Biometrika*, Vol. II, pp. 481—498. A joint memoir, 1903.
(35) [Measurements and observations on Lesser Celandine. Unpublished.]
(36) Inheritance in *Phaseolus vulgaris*. *Biometrika*, Vol. II, pp. 499—503. Joint review, 1903.
(37) [A Determinantal Theory of Inheritance. Unpublished.]
(38) Inheritance in Animals and Plants. *Lectures on the Method of Science.* Edited by T. B. Strong, Oxford, 1906.
(39) Note on the Offspring of Thoroughbred Chestnut Mares. *R. S. Proc.* Vol. 77B, pp. 394—398, 1906.
(40) [Material for an extensive memoir on the Inheritance of Coat-colour in Thoroughbred Horses. Unpublished.]
(41) Article on *Crustacea* for the *Cambridge Natural History*—fragmentary, except for a chapter on the *Phyllopods* already set up.
(42) [A Treatise on Inheritance, largely completed.]
(43) A portion of an account of the *Heliozoa* for the *Oxford Natural History.*
(44) Account of Kölliker's scientific work. *Nature*, Vol. LVIII, pp. 1—4, 1898.
(44) *bis* Dreyer's Peneroplis, eine Studie zur biologischen Morphologie und zur Speciesfrage. (A review.) *Nature*, Vol. LIX, pp. 364—5, 1899.
(45) Account of Huxley's scientific work for the Supplement to the *Dictionary of National Biography*, 1900.
(46) Article on *Variation* in the "Times" Supplement to the *Encyclopaedia Britannica.*

VARIATION IN CHILOMONAS UNDER FAVOURABLE AND UNFAVOURABLE CONDITIONS.

By RAYMOND PEARL.

For some time past it has seemed to the writer that much of value for the elucidation of the problems of morphogenesis might be gained by quantitative investigations which should give more precise information than we now have of the effects of different environmental conditions on the formative activities of protoplasm. It is, of course, well known that in general the form of an organism is directly influenced by the environment in which it lives. Further the brilliant investigations of such experimental morphologists as Driesch, Herbst, and Morgan, for example, have shown for individual organisms the particular qualitative change which follows a given definite change in the environment. Such investigations can only be regarded as of the highest value and importance, and the field they open up is likely to be one of the most fruitful in biology. Furthermore it seems to me to be a field in which much of fundamental significance may be brought out by the application of the methods of biometry. It is not the place here to enter upon a general discussion of the grounds for this opinion. The time for such a discussion is after a respectable body of objective results have been gleaned by biometric investigations in the field of experimental morphology. It will not, however, be out of place to outline very briefly the nature of some of the problems of morphogenesis which seem especially to need biometric treatment, as in this way the standpoint from which the writer's work in biometry is being done may most easily be made clear. One such problem is this: to what extent and in what manner is the relative constancy of form production capable of modification? Thus, to take a concrete instance, are "lithium" sea-urchin larvae reared under uniform conditions relatively more or less constant (or, if one pleases, less or more variable) in form than are normal larvae reared under uniform conditions? Driesch has strongly emphasized that one of the most fundamental problems which biology presents is that, to use his own term, of the "Lokalization morphogenetischer Vorgänge." His own work has served the admirable purpose of very sharply and clearly defining the nature of this problem. For its solution, however, he has turned to a teleological principle the "entelechy" of the system. But before taking such a radical step it seems not undesirable to investigate more thoroughly than has been done the nature and laws of this "Lokalization." After all, how precise is it? Driesch has frequently cited as one of the most striking of the phenomena which led him to adopt a vitalistic hypothesis, the proportionate division by constriction of the intestine of a sea-urchin larva into three parts.

Whether the larva develops from a normal egg, a half-blastomere, or a quarter-blastomere, the proportionality of the three regions of the intestine so marked off is said to be constant. But how constant is it? Is there really as great precision in the relative localisation of the constrictions in the embryo from a half-blastomere as there is in the embryo from the normal egg? For Driesch's point of view an affirmative answer to this question seems to me to be vitally important. But clearly it is a question which cannot be answered by general inspection of individuals, nor by the measurement of a comparatively few isolated cases. Its answer must depend on the accurate determination of the probable errors of what must in the nature of the case be absolutely very small differences*. To answer satisfactorily such a question we must, it seems to me, turn to the biometric method of attack. It is, then, in connection with such problems of morphogenesis as these outlined that I believe much is to be gained by the application of the methods of biometry.

From this general orientation we may turn to the specific problem in connection with which the present work was done. During the past three years I have been engaged on an investigation (in connection with some of the students in biology at the University of Michigan) of the effect of environmental conditions on the form of the body in the Protozoa. An experimental study of certain phases of the problem has been made on Paramecium, of which a preliminary report has been published (Pearl and Dunbar, 1905). The results of that work made it seem desirable to get similar data for some other protozoan, where the environmental differences should be such as appear in the course of the normal life of the organism, rather than those experimentally induced. It was desirable to compare the variability and correlation shown by a population living under the most favourable natural conditions with the same characteristics of a population living under extremely unfavourable natural conditions. To present the results of such a comparison for the flagellate infusorian *Chilomonas* is the purpose of this paper. It has seemed best to publish these results in advance of the complete paper on Paramecium, as it is likely to be some time before that appears and the present results lend themselves readily to separate treatment.

The particular protozoan chosen for the work, *Chilomonas paramecium*, seems especially well adapted for biometrical studies. It has a definite and constant form; its protoplasm is relatively dense, and hence little affected by osmotic changes in the surrounding medium, a point of practical importance in quantitative work on Protozoa; and it can be had everywhere in abundance. It may perhaps be well to recall very briefly some of the facts regarding the biology of the form. *Chilomonas* is a very minute infusorian, which commonly appears in great numbers in cultures containing decaying plant material. The body forms an elongated ovoid with an asymmetrically situated depression or notch near the anterior end. From the base of this notch spring two flagella (cf. Fig. 1, p. 56). Its nutrition is saprophytic and the usual method of reproduction is by longitudinal fission. An excellent account (with figures) of this organism has been given by Bütschli (1878).

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* Of course in the particular case cited of the proportional division of the intestine the *practical* difficulties in the way of measuring may be insuperable, but this in no way affects the point of principle that in this and similar cases quantitative treatment of the problems of morphogenesis is necessary if real advance is to be made.

Material and Methods.

The material on which this study is based was taken from two cultures set in the ordinary way for rearing Protozoa with pond-water and decaying plant material. One of the cultures was made with dry hay and pond-water (Culture B), and the other (Culture A) with dead and decaying water-plants from the same source as the water itself. The source of the water in both cultures was the same. Both of these cultures ran the ordinary course, rising to a maximum of animal and plant life and then gradually falling off. Both passed through a stage in which *Chilomonas* was especially abundant. The associated organisms were in general the same in both cultures, the most abundant forms, in point of numbers, being *Paramecium caudatum* and a large *Spirillum*. In the hay culture *Chilomonas* was extremely abundant and very evidently in a flourishing condition when the samples were taken for measurement. Judged by the standards of (*a*) abundance, (*b*) size of individuals, (*c*) appearance of the protoplasm, and (*d*) activity, it could only be concluded that the environmental conditions in Culture B at the time the samples were taken were at an optimum for *Chilomonas*. The series taken from this culture, which will be designated throughout the paper as Series B, may, then, be considered to represent the prevailing condition (for this particular race, of course) of *Chilomonas* growing under *favourable* circumstances.

On the other hand, when the samples were taken for measurement from Culture A the conditions were very different. This culture had at that time passed the optimum for infusorian life, and all the organisms were rapidly disappearing. All the Paramecia, which had previously been abundant in the culture, had disappeared, and the numbers of individuals of *Chilomonas* and *Spirillum* were being rapidly reduced. Some notion of the rapidity with which this reduction was going on may be gathered from the fact that on the day following that on which the samples were taken one could only with difficulty find specimens of *Chilomonas*, while on the second day after the sampling careful search failed to obtain any specimens. The culture had apparently completely "run out" as far as infusorian forms were concerned. The series taken from this culture (Series A) may be considered to represent the character of the local race of *Chilomonas* when living under the most *unfavourable* environmental conditions which the individuals were capable of withstanding in the active state. It will thus be seen that the individuals of Series A were in a sense practically the ultimate "survivors" of the progressively worsening conditions of the culture. But it must be understood that this does not mean that they were survivors in any process of destruction of the race. *Chilomonas*, in common with most other infusoria, encysts when the environmental conditions become so unfavourable that it is unable to withstand them any longer in the active condition. The cysts of *Chilomonas* have been figured by

Bütschli (1883–87, Taf. XIV, Fig. 9 *c*). When the infusorian life begins to disappear from a culture it usually means that the organisms are encysting rather than dying. That this is the case is clearly shown by the fact that by appropriately changing the culture medium they may be induced to reappear again in the active condition. This fact is, of course, well known to all who have worked to any extent with Protozoa.

For the present purpose it is not of immediate consequence to know what the optimum conditions for infusorian life are, or, on the other hand, in what manner the cultural conditions become so unfavourable as to lead to the encystment of these organisms. It is of course a well-known phenomenon that laboratory cultures usually and normally pass through both these stages. The important investigation of Peters (1904) in this field indicates clearly that the basis of the matter lies in the changing chemical constitution of the culture medium. From the present standpoint it is sufficient to note that the "favourable" conditions of Culture B and the "unfavourable" conditions of Culture A were in no way artificially or experimentally induced, but appeared in a normal way in the undisturbed cultures.

With reference to the technique used in the collecting and measuring the following may be said. Samples were taken from each of the cultures with a clean pipette quite at random. These samples were then killed with Worcester's formol-sublimate fluid (Pearl, 1903). This fluid has been used by the writer in a number of biometric studies on Protozoa, and has proved very satisfactory for the purpose. With *Chilomonas* it is possible to prove that killing with this fluid when properly performed produces no measurable distortion of the organism. After killing, the specimens were measured by the camera lucida method which has been used by the writer and his students in other similar studies. (Cf. for description of methods, Pearl and Dunbar, 1903, and Pearl, 1906.) The magnification used in the present instance was such that 1 mm. on the cards on which the dimensions were pricked with a needle point corresponded to 1·45 mikrons (= × 689·7 linear). The measurements are given in mikrons.

The characters measured were length (C—D) and greatest breadth (A—B) of the body as shown in Figure 1. An attempt was made to measure the flagella, which appear with perfect distinctness in specimens killed with the formol-sublimate fluid, but it was not feasible on account of the too frequent curvature of a flagellum either up or down in the line of sight. In addition to the absolute length and

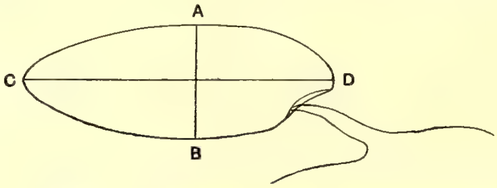

FIG. 1. Outline of *Chilomonas* to show measurements taken.

breadth dimensions, the variation in the length-breadth index has also been studied.

Series A included 201 individuals and Series B 175 individuals. Larger numbers would have been measured but for the fact that the work on *Chilomonas* was interrupted by other work which had to be carried on while the material was available. With the degree of variation exhibited by *Chilomonas*, however, these numbers lead to reasonably small values for the probable errors of the constants and hence we are able to reach definite conclusions.

In the calculation of the constants the ordinary biometrical methods were followed. Sheppard's corrections for the moments were used in all cases.

The work was done in the Zoologisches Institut at Leipzig, and it is a pleasure to express my thanks to Professor Carl Chun and Professor Otto zur Strassen for so kindly placing the facilities of that laboratory at my disposal. I am also greatly indebted to the Carnegie Institution for a grant, during the tenure of which this investigation was carried out.

Results.

The data for the length and breadth of the individuals measured are exhibited in Tables I and II. Table I gives the data for Series A, that is, the individuals living under unfavourable conditions, while Series B including the individuals living under favourable conditions is given in Table II.

TABLE I.

Length and Breadth of 201 *Individuals of Chilomonas paramecium. Series A. Unfavourable conditions.*

Breadth in mikrons.

Length in mikrons.	*6·5—6·9*	*7·0—7·4*	*7·5—7·9*	*8·0—8·4*	*8·5—8·9*	*9·0—9·4*	*9·5—9·9*	*10·0—10·4*	*10·5—10·9*	*11·0—11·4*	*11·5—11·9*	*12·0—12·4*	Totals
14·0—14·9	—	—	1	—	—	—	—	—	—	—	—	—	1
15·0—15·9	—	—	—	—	—	—	—	—	—	—	—	—	—
16·0—16·9	—	1	—	—	—	—	—	—	—	—	—	—	1
17·0—17·9	—	1	1	—	—	2	—	—	—	—	—	—	4
18·0—18·9	—	2	1	4	3	2	1	—	—	—	—	—	13
19·0—19·9	1	1	—	2	1	6	1	—	—	—	—	—	12
20·0—20·9	1	2	4	3	8	10	3	2	—	—	—	—	33
21·0—21·9	—	—	1	3	8	5	5	1	—	—	—	—	23
22·0—22·9	—	—	1	—	5	8	7	3	1	—	1	—	26
23·0—23·9	—	—	—	—	1	10	7	6	2	3	—	—	29
24·0—24·9	—	—	—	—	—	5	3	3	3	4	—	—	18
25·0—25·9	—	—	—	—	1	—	6	3	3	2	2	1	18
26·0—26·9	—	—	—	—	—	2	3	4	2	1	3	—	15
27·0—27·9	—	—	—	—	—	1	1	3	—	—	—	—	5
28·0—28·9	—	—	—	—	—	—	—	1	—	—	2	—	3
Totals	2	7	9	12	27	51	37	26	11	10	8	1	201

TABLE II.

Length and Breadth of 175 *Individuals of Chilomonas paramecium. Series B. Favourable conditions.*

Breadth in mikrons.

Length in mikrons.	*7·5—7·9*	*8·0—8·4*	*8·5—8·9*	*9·0—9·4*	*9·5—9·9*	*10·0—10·4*	*10·5—10·9*	*11·0—11·4*	*11·5—11·9*	*12·0—12·4*	*12·5—12·9*	*13·0—13·4*	*13·5—13·9*	*14·0—14·4*	*14·5—14·9*	*15·0—15·4*	Totals
17·0—17·9	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1
18·0—18·9	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
19·0—19·9	—	1	1	1	2	—	—	—	—	—	—	—	—	—	—	—	5
20·0—20·9	—	1	1	1	1	1	—	—	—	—	—	—	—	—	—	—	5
21·0—21·9	—	—	—	—	5	2	2	—	—	—	—	—	—	—	—	—	9
22·0—22·9	1	—	—	2	1	8	1	2	1	3	—	—	—	—	—	—	19
23·0—23·9	—	—	1	2	8	8	6	4	3	—	—	1	—	—	—	—	33
24·0—24·9	—	—	—	2	7	6	7	6	3	2	2	—	—	—	—	—	35
25·0—25·9	—	—	—	1	2	1	6	3	1	4	—	—	—	—	—	—	18
26·0—26·9	—	—	—	—	1	2	3	5	2	1	1	—	—	—	—	—	15
27·0—27·9	—	—	—	—	—	—	3	5	4	1	1	1	1	—	—	—	16
28·0—28·9	—	—	—	—	—	2	—	2	1	1	—	1	—	1	—	—	8
29·0—29·9	—	—	—	—	—	—	1	—	2	2	—	—	—	—	—	1	6
30·0—30·9	—	—	—	—	—	—	—	1	—	—	—	2	—	—	—	—	3
31·0—31·9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
32·0—32·9	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1
Totals	2	2	3	10	27	30	29	28	17	15	4	5	1	1	—	1	175

We may first consider the variation in length and breadth for the two series from the analytical standpoint. In Table III are given the chief analytical constants of the distributions. The moment-coefficients are given in units of 1 mikron for the lengths, and of ·5 mikron for the breadths.

TABLE III.

Analytical Constants for Variation in Chilomonas.

Constant	Series A.		Series B.	
	Length	Breadth	Length	Breadth
μ_2	6·9137	4·4534	6·4739	5·5237
μ_3	− ·0494	·3113	2·9056	5·5862
μ_4	122·6396	62·1412	133·9061	118·4789
β_1	·000007	·0011	·0311	·1852
$\sqrt{\beta_1}$	·0027	·0331	·1763	·4303
β_2	2·5657	3·1332	3·1950	3·8831
$\beta_2 - 3$	− ·4343	+ ·1332	+ ·1950	+ ·8831
κ_1	− ·8685	·2632	·2966	1·2107
κ_2	− ·000006	·0022	+ ·0793	·1209
Skewness	− ·00198	+ ·0153	+ ·0805	+ ·1592
d	− ·0052 mikrons	·0161 mikrons	+ ·2048 mikrons	+ ·1870 mikrons

This table brings out a number of points of interest, but before considering it in detail it is necessary to have before us the values of the probable errors of certain of the constants, on the assumption that all the distributions obey the normal or Gaussian law. The formulae for these probable errors have been given by Pearson (1905 and elsewhere), and it is unnecessary to repeat them here. In Table IV are given the values of the probable errors of the four constants which are of the most importance in testing whether a distribution significantly differs from the normal law, viz., $\sqrt{\beta_1}$, β_2, skewness, and the "modal divergence," *d*.

TABLE IV.

Probable Errors of Constants for Normal Distribution.

Constant	Series A. N = 201	Series B. N = 175
$\sqrt{\beta_1}$	±·1165	±·1249
β_2	±·2331	±·2498
Skewness	±·0583	±·0624
d Length	±·1532 mikrons	±·1589 mikrons
d Breadth	±·0615 "	±·0734 "

Examining the values given in Table III in connection with those for the probable errors in Table IV we see at once a number of differences between Series A and Series B. Considering first the question of the symmetry of the distributions, it is evident, from the values of $\sqrt{\beta_1}$ and of the skewness, that for Series A the distributions of both length and breadth are symmetrical within the limits of the errors of random sampling. In both distributions the skewness and $\sqrt{\beta_1}$ differ from their theoretical value (if the distribution be truly symmetrical) of zero, by only small fractions of their probable errors. With Series B the case is different: here both the length and breadth distributions give values for $\sqrt{\beta_1}$ and skewness which differ from zero by more than their probable errors. In the case of the breadths this deviation rises to more than twice the value of the probable error. It is probable that we have to do with real skewness here, and not simply with an effect of random sampling. An examination of the "modal divergence" leads to the same result: namely, in both the length and breadth distribution of Series A the mode does not significantly differ from the mean, while in Series B the value of *d* is for both distributions greater than its probable error. For the breadths this divergence of *d* from zero is about 2·6 times its probable error. The skewness is positive in both of the Series B distributions, or the mean is greater than the mode.

Turning to the kurtosis (cf. Pearson, 1905, p. 173) measured by the quantity $\eta = \beta_2 - 3$, it is seen that for the lengths in Series A it has a value of $-$·4343, with a probable error (if the distribution were truly mesokurtic) of ± ·2331. We conclude then that the distribution is probably significantly leptokurtic (i.e. is less flat-topped than the normal curve), and that we shall get better results if we graduate with some curve, which, while still remaining symmetrical about the mean, has a sharper peak than does the normal curve. The breadth distribution for Series A is sensibly mesokurtic, with a value of $\eta = \cdot 1332$ and a probable error of $\pm \cdot 2331$. The same is true for the length distribution of Series B, though in this case the value of η is somewhat larger. The breadths in Series B give a value for η of $+ \cdot 8834$ with a probable error of $\pm \cdot 2498$; the distribution is significantly platykurtic.

Putting all the results together we conclude that the individuals of Series A vary symmetrically about their type condition, while those of Series B exhibit skew variation. For the character length this skewness is slight and taken by itself could not be considered significant, but considering that the length and breadth distributions of this series (B) exhibit deviations from normality in the same direction with respect to all constants we may safely conclude, I think, that we are dealing with a case of real skewness. This conclusion is of interest when it is recalled that Series A represents the extreme of unfavourable environmental conditions, and Series B the optimum environment. This point will be more fully discussed farther on in the paper.

From the values of κ_1 and κ_2, β_1 and β_2, it is clear that the length distribution of Series A calls for a curve of Type II; the breadth distribution of Series A for a normal curve; while both length and breadth distributions of Series B demand curves of Type IV.

The frequency distributions and their fitted curves are shown graphically in Figures 2 and 3. The equations to the curves are:

Series A, Length.

$$\text{Type II.} \quad y = 28{\cdot}5889 \left(1 - \frac{x^2}{81{\cdot}69698}\right)^{4{\cdot}4084}$$

Origin at mode $= 22{\cdot}555$ mikrons.

Series A, Breadth.

$$\text{Normal.} \quad y = 37{\cdot}9978\, e^{-{\cdot}4491\, x^2}$$

Origin at mode $= 9{\cdot}479$ mikrons.

Series B, Length.

$$\text{Type IV.} \quad y = 4{\cdot}7077\, (\cos\theta)^{45{\cdot}7771}\, e^{12{\cdot}8514\,\theta}$$

$$x = 15{\cdot}9676 \tan\theta$$

Origin at $19{\cdot}973$ mikrons.

Series B, Breadth.

$$\text{Type IV.} \quad y = 14{\cdot}5990\, (\cos\theta)^{15{\cdot}3703}\, e^{4{\cdot}9594\,\theta}$$

$$x = 7{\cdot}7502 \tan\theta$$

Origin at $9{\cdot}375$ mikrons.

Considering the small number of observations these curves give very good graduations. The skewness of the Series B distributions is very apparent in these diagrams. They also show clearly to what a marked degree the type of the individuals in favourable conditions differs from that of the individuals living under unfavourable conditions. The exact amount of this difference is however more directly brought out by a comparison of the chief physical constants of the distributions, to which we may now turn.

In Table V are given the means, standard deviations, and coefficients of variation, for the characters length, breadth, and index, in the two series. In order to facilitate comparison I have also tabulated the absolute differences (with their probable errors) between the corresponding constants of the two series. The differences are given the plus sign when the Series B constant is the greater and the minus sign in the opposite case.

TABLE V.

Comparison of Type and Variability of Chilomonas Living under Favourable and Unfavourable Conditions.

Character	Series	Mean	Standard Deviation	Coefficient of Variation
Length	B, Favourable conditions	24·660 ± ·130 mikrons	2·544 ± ·092 mikrons	10·318 ± ·376
„	A, Unfavourable „	22·555 ± ·125 „	2·629 ± ·088 „	11·658 ± ·397
„	Difference	+2·105 ± ·180 „	– ·085 ± ·128 „	–1·340 ± ·547
Breadth	B, Favourable conditions	10·813 ± ·060 mikrons	1·175 ± ·042 mikrons	10·868 ± ·396
„	A, Unfavourable „	9·479 ± ·050 „	1·055 ± ·035 „	11·132 ± ·379
„	Difference	+1·334 ± ·078 „	+ ·120 ± ·055 „	– ·264 ± ·548
Index	B, Favourable conditions	44·060 ± ·203 °/₀	3·972 ± ·143 °/₀	
„	A, Unfavourable „	42·137 ± ·191 °/₀	4·006 ± ·135 °/₀	
„	Difference	+1·923 ± ·279	– ·034 ± ·197	

It is seen at once that the differences between the two series in respect to type are large. The individuals living under favourable conditions are longer and broader both absolutely and in proportion to their length than are those living under unfavourable conditions. There can be no doubt that these differences between the means are significant in comparison with their probable errors. This result shows clearly that even in such a form as *Chilomonas* the conditions of existence which are favourable to rapid multiplication are also favourable to large size of body. Such a relation is, of course, to be expected in an organism reproducing sexually, but it is not so obviously necessary *a priori* in an organism reproducing by fission. In fact, it might on general grounds be maintained that when the conditions were such as to lead to very rapid reproduction by fission, the average size of the individuals would diminish, on account of fission taking place before the maximum growth possible had occurred. The present data show that such is not the case, however.

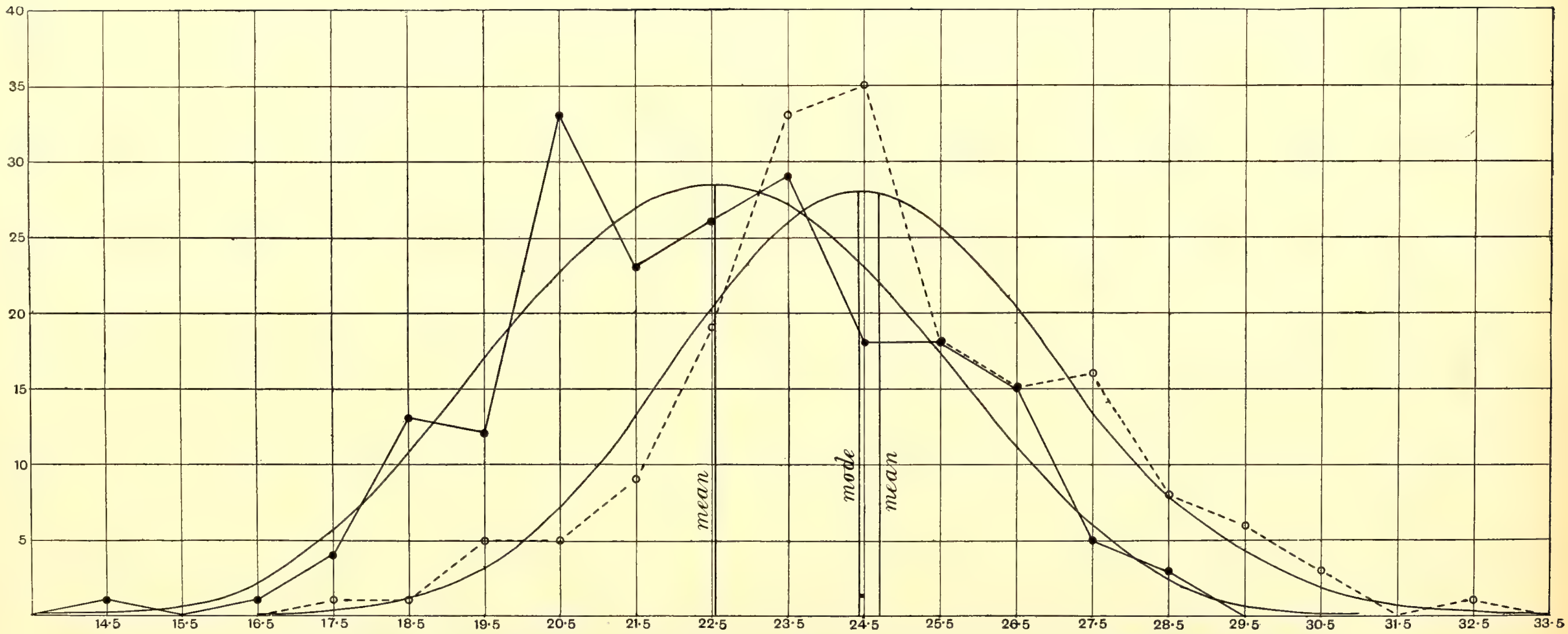

FIG. 2. Diagram showing variation in length of *Chilomonas* under favourable and unfavourable environmental conditions.

●——● = Series A (Unfavourable conditions). ○- - -○ = Series B (Favourable conditions).

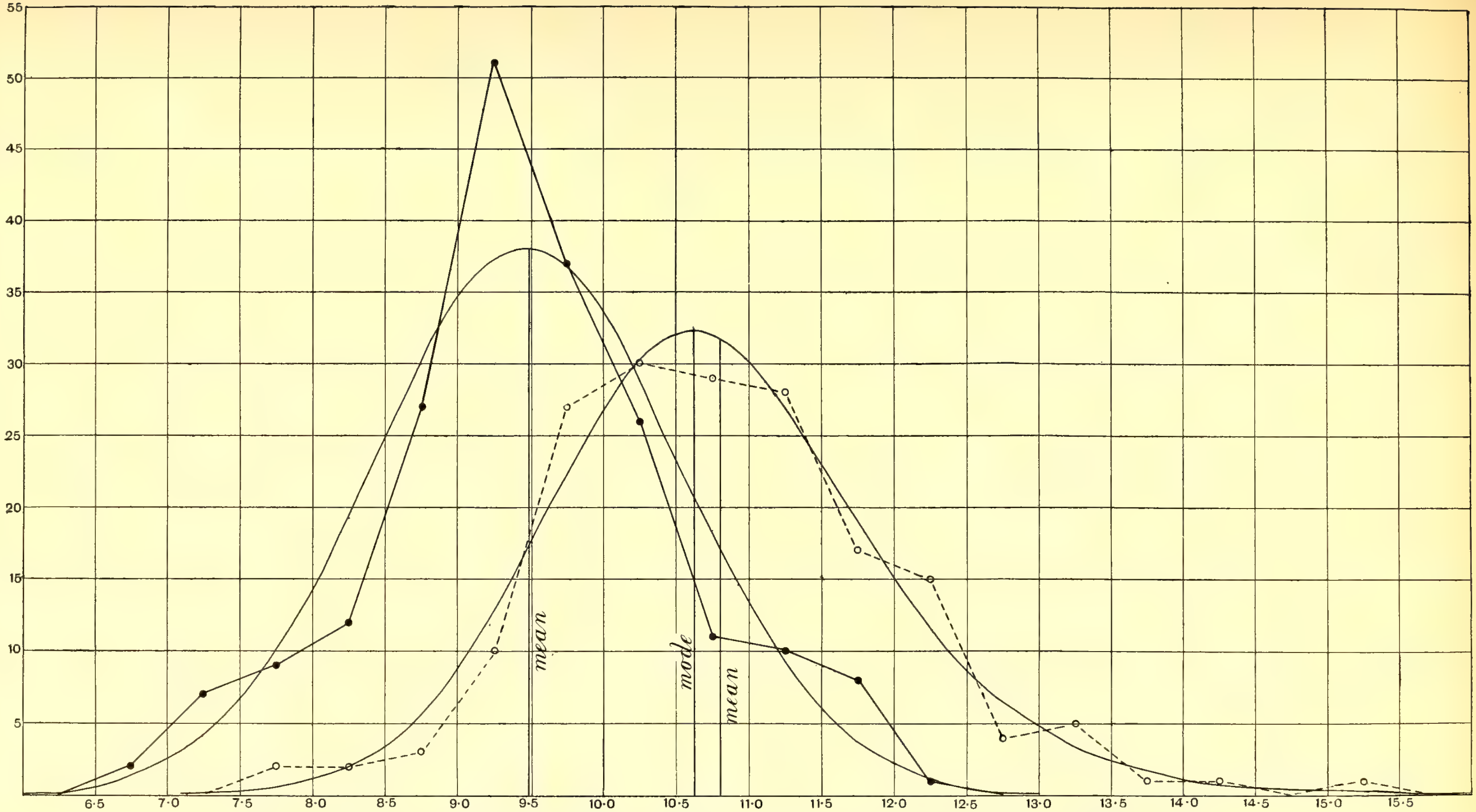

FIG. 3. Diagram showing variation in breadth of *Chilomonas* under favourable and unfavourable environmental conditions.

●——● = Series A (Unfavourable conditions). ○ - - - ○ = Series B (Favourable conditions).

In view of the striking difference in type between the two series it is somewhat surprising to find them so nearly alike in variability. For none of the characters can the differences in the variation constants be said to be significant. It is worth noticing, however, that, with a single exception (the absolute variation in breadth) the differences between the variation constants, both absolute and relative, are negative. That is to say, the individuals of Series A, living under *unfavourable conditions*, are slightly more variable than those of Series B, living under favourable conditions. The differences are so small in comparison with their probable errors, however, that no particular stress is to be laid upon this fact. The conclusion to which we must come from the present data is that there is no marked difference in variability between individuals living under conditions which in the one case were very favourable and in the other case very unfavourable to the continued existence of the race in the active condition. What slight preponderance exists is in favour of greater variation under unfavourable conditions.

We may next examine the correlation between length and breadth of body for the two series. The raw material is given in Tables I and II, whence, calculating the coefficient of correlation by the usual formula $r = \frac{S(xy)}{N\sigma_1\sigma_2}$, we get:

Series A (Unfavourable conditions) $r = \cdot683 \pm \cdot025$

Series B (Favourable conditions) $r = \cdot617 \pm \cdot032$

Difference $= \cdot066 \pm \cdot041$

These values of the coefficients are high, indicating a closer relationship between length and breadth of body in this simple protozoan than would have been predicted, I think. Just as in the case of the simple variation, however, there is no certainly significant difference between the two series in respect to degree of correlation. What difference there is is in favour of higher correlation under unfavourable conditions, but no great stress is to be laid on the difference.

Since biometric investigations on Protozoa are as yet not especially numerous, it seems desirable to examine the regression for these two characters, length and breadth, to determine whether it is linear or not. The equations to the regression coefficients are as follows:

Series A, Length on breadth.

$$b_1 = \frac{2\cdot6294}{1\cdot0552} \times \cdot6832 = 1\cdot7024.$$

Series A, Breadth on length.

$$b_2 = \frac{1\cdot0552}{2\cdot6294} \times \cdot6832 = \cdot2742.$$

Series B, Length on breadth.

$$b_1 = \frac{2{\cdot}5444}{1{\cdot}1751} \times {\cdot}6168 = 1{\cdot}3355.$$

Series B, Breadth on length.

$$b_2 = \frac{1{\cdot}1751}{2{\cdot}5444} \times {\cdot}6168 = {\cdot}2849.$$

From these values we easily obtain the following characteristic equations, in which L signifies "length of body" in mikrons, and B "breadth of body" in mikrons.

$$\text{Series A} \begin{cases} \text{Probable } L = 1{\cdot}7024\,B + 6{\cdot}418 \\ \text{Probable } B = {\cdot}2742\,L + 3{\cdot}295 \end{cases}$$

$$\text{Series B} \begin{cases} \text{Probable } L = 1{\cdot}3355\,B + 10{\cdot}219 \\ \text{Probable } B = {\cdot}2849\,L + 3{\cdot}787 \end{cases}$$

The means of the arrays and the fitted regression lines are shown in Figures 4 and 5.

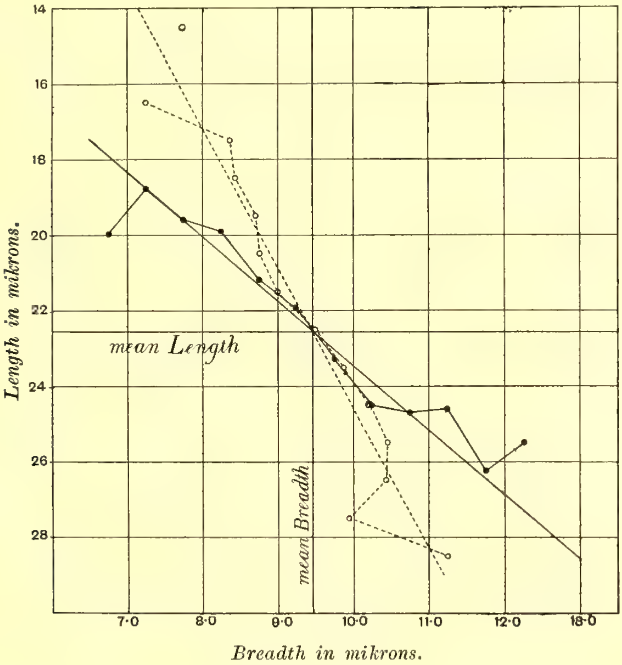

FIG. 4. Regression lines for Series A (Unfavourable conditions). •——• = Regression of length on breadth. o – – – o = Regression of breadth on length.

It is evident that the regressions are very closely linear. This result is in accord with what has been found for the other Protozoa for which this point has been determined, namely Arcella (Pearl and Dunbar, 1903) and Paramecium (Pearl,

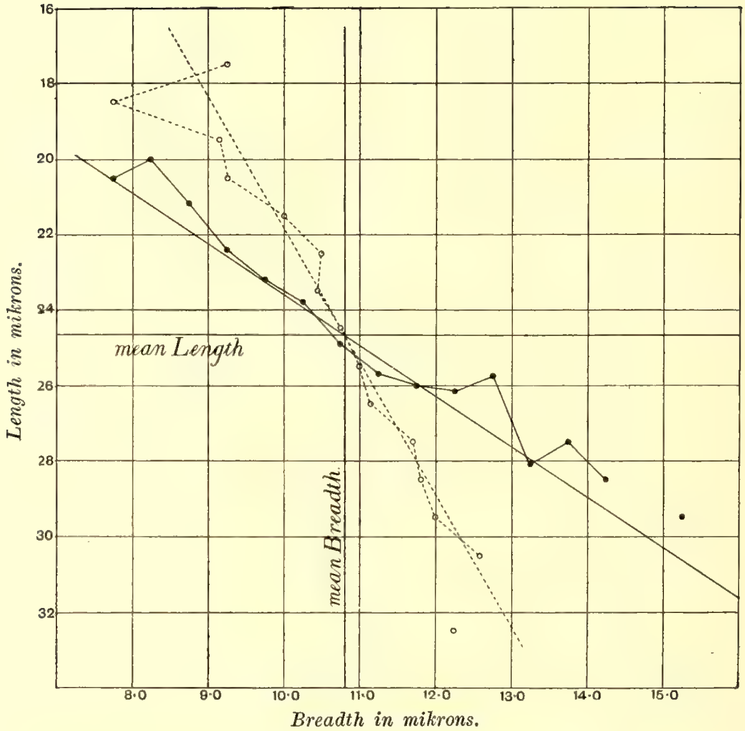

FIG. 5. Regression lines for Series B (Favourable conditions). •——• = Regression of length on breadth. o – – – o = Regression of breadth on length.

1906). It seems to me to be a result of considerable significance that in organisms representing three of the important types of protozoan structure (namely the Rhizopoda, Flagellata, and Ciliata) the regression between size characters is substantially linear. Biometric work on a variety of multicellular organisms has shown that in such forms linear regression between size characters in the fully developed (i.e. adult) organism is practically the universal rule. To find the same thing true of Protozoa seems to me to be definite quantitative evidence that the factors concerned in regularity of form production, if not the same, at least operate in fundamentally similar ways in unicellular and multicellular organisms.

We may next examine the index correlations. It is of considerable theoretical interest to know what degree of correlation exists between the length-breadth index and each of the characters entering into it. We shall then have a measure of the extent to which size of body and shape of body are associated in their variations. These correlations may be determined from formulae which are readily deduced from the fundamental theorems regarding the variation and correlation of indices given by Pearson (1897). The particular formulae used in the special case with which we have to do here are given in another paper by the present writer (1906), and need not be repeated. The values found for the index correlations of *Chilomonas* are given in Table VI.

TABLE VI.

Index Correlations in Chilomonas.

Series	Characters	Gross (ρ)	Spurious* (ρ_0)	Net* ($\rho - \rho_0$)
A (Poor conditions)	Index and Length	$-\cdot446 \pm \cdot038$	$-\cdot723 \pm \cdot023$	$+\cdot277 \pm \cdot044$
B (Good „)	„ „ „	$-\cdot389 \pm \cdot043$	$-\cdot689 \pm \cdot027$	$+\cdot299 \pm \cdot046$
A (Poor „)	„ „ Breadth	$+\cdot407 \pm \cdot040$	$+\cdot723 \pm \cdot023$	$-\cdot317 \pm \cdot043$
B (Good „)	„ „ „	$+\cdot426 \pm \cdot042$	$+\cdot689 \pm \cdot027$	$-\cdot263 \pm \cdot047$

In this table the column headed "Gross" gives the observed correlations between the designated characters; the column headed "Spurious" gives the value which this correlation would take if the organic correlation between length and breadth did not exist; and finally the column headed "Net" gives the portion of the "gross" coefficient which is due to the existence of an organic correlation between the index and the particular character under consideration.

From the values in Table VI we see that:

(*a*) The net organic correlation between the length-breadth index and length is positive, while the correlation between the index and breadth is negative. Thus the net correlations are opposite in sign to what the gross correlations are. The sign of the *gross* coefficients is in each case what we should expect it to be for arithmetical reasons, because the length is the denominator and the breadth the numerator of the index fraction.

(*b*) The net coefficients are of considerable magnitude, and represent clearly a sensible real correlation between the index and the absolute dimensions. They show that there is a definite correlation in this form between shape and size of body. The theoretical bearing of this result will be discussed farther on in the paper.

(*c*) The index correlations are of sensibly the same magnitude in both series, as are the correlations for absolute size characters (cf. *supra*, p. 64).

(*d*) The index is correlated more closely with breadth than with length in Series A, where the environment was unfavourable, while the opposite relation prevails in Series B, with a favourable environment. The differences are small, however, and no great stress is to be laid on them.

Without at this time entering upon any discussion of the matter, I should like merely to call attention to the fact that the values for the variation and correlation constants for *Chilomonas* agree very well with what we have found for similar characters in other Protozoa. From Table V we see that the coefficients of variation for length and breadth in *Chilomonas* have values ranging roughly between 10·5 and 11·5. There is no sensible difference in relative variability between length and breadth of body. For Arcella we have for the diameter of the shell a coefficient of variability of 10·27, and for the diameter of the "mouth" opening a coefficient of 13·66 (cf. Pearl and Dunbar, *loc. cit.*). The mean value of the coefficient of variation in length of body for a series of Paramecia reared under various environmental conditions and including all told 4900 individuals is 8·45 (cf. Pearl, *loc. cit.*). All these values cluster well together, and point to a value of roughly 10 per cent. for the coefficient of variation in size characters of this kind in Protozoa.

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* The probable errors in the "spurious" and "net" columns are calculated from the usual formula for the probable error of a correlation coefficient, P.E. $r = \cdot67449 \frac{1 - r^2}{\sqrt{n}}$. This assumes that the probable error of these constants is the same as it would be if they had been determined from the product moment. The error involved in this assumption is probably insignificant.

Discussion of Results.

It now remains to consider the meaning of the facts set forth in the preceding sections. These facts may be summarily stated as follows: comparing two populations of the same local race of the flagellate Infusorian *Chilomonas paramecium*, one of which populations was living under the most favourable of environmental conditions and the other under the least favourable conditions, we find:

(1) That in respect to absolute length and breadth of body and in shape of body as measured by the length-breadth index, the *types* of the two populations are significantly different. Those living in the least favourable conditions are smaller and relatively slenderer than the individuals in an optimum environment.

(2) In respect to the characters dealt with, both populations are equally variable, and have their parts correlated to an equally high degree. There is a slight tendency for the individuals living in the unfavourable environment to be more variable and more highly correlated, but in view of the probable errors the differences cannot be said to be certainly significant.

(3) The individuals living under unfavourable conditions vary symmetrically about their typical condition, while the group from the optimum environment exhibit an unsymmetrical or skew variation about the type.

(4) There is a sensible correlation between the absolute size of the body and its shape as measured by the length-breadth index.

The first of these results is exactly what we should expect to find, on general grounds. There can be little doubt that one of the chief factors which induce saprophytes like *Chilomonas* to disappear from a culture is that the medium no longer furnishes proper food (either in amount or kind, or both). The Series A individuals are in all probability to be regarded as "starved." We should in consequence expect them to be smaller than the flourishing individuals of Series B. Similar cases of diminution in size in organisms living in unfavourable environments have recently been described by Dimon (1902) for *Nassa*, and by Warren (1902) for *Hyalopterus*.

It is of more interest to find that in spite of the great change in the type between the two populations there is no marked difference in the amount of variation. That is to say, relatively equal degrees of aberration from the typical condition are, on the whole, produced with equal frequency in the two populations. Thus there is apparently nothing like a selective process in the encystment of this form. The last individuals to "survive" in the active condition are as variable as the general population.

The third result appears to be worthy of notice. For both length and breadth there is a positive skewness in the variation of the individuals in the optimum environment. That is to say, the mean falls to the right of the mode, or the curve tends to "tail out" more on the side of large individuals than in the opposite direction. This indicates that the conditions which are favourable to the production of large size of body in the population as a whole, are also more favourable to the production of exceptionally large than of exceptionally small individuals. In other words, the direction of the skewness is the same as the direction in which the type is changing. May not this relation be generally true when a change of type is brought about by direct environmental action rather than by selection, the distribution finally becoming symmetrical when the possible limit of direct modification of the type is reached? The results from both series of *Chilomonas* are in accord with such a view, but of course are altogether too meagre to base more than a suggestion upon. The question will be more definitely tested on Paramecium material collected *ad hoc.*

The result that shape of body as measured by the length-breadth index is sensibly correlated with absolute size seems to me to have such important theoretical significance that it appears desirable to discuss the matter in some detail. At the outstart I may say that the results from *Chilomonas* on this point are by no means an isolated case. I have elsewhere shown (1906) on material comprising a number of fairly long series that the same thing is true for Paramecium, with, of course, differences of detail in the values of the constants. The following table gives the values of the net organic correlations between index and length and breadth of body in three lots of Paramecium, comprising altogether 544 individuals. Other data are given in the paper referred to, but these will be sufficient for comparison in the present instance.

TABLE VII.

Correlation of Index with Absolute Dimensions in Paramecium.

Series*	Characters	Net Correlation $(\rho - \rho_0)$
A	Length and Index	·4134 ± ·0386
"	Breadth " "	− ·2246 ± ·0442
C	Length " "	·3692 ± ·0410
"	Breadth " "	− ·2497 ± ·0445
E	Length " "	·3556 ± ·0513
"	Breadth " "	− ·2964 ± ·0535

* The letters designating the series are those used in the original paper.

Comparing these values with those for *Chilomonas* in Table VI above, we see that the signs of the correlations are the same in the two cases: the index is positively correlated with length and negatively with breadth. In Paramecium the correlation is distinctly higher between length and index than between breadth and index, a relation which apparently does not exist in *Chilomonas*. These differences are, however, not of importance for our present purpose. The essential fact is that in these two unicellular organisms *there is a significant correlation between shape of body and absolute size.*

Now Driesch (1900, 1901 and elsewhere) has stated as one of the most fundamental laws of morphogenesis that the *proportionality* of the parts in a differentiated system is absolutely independent of the size of the system. Thus in the case which has already been mentioned (p. 53) he holds that the proportions of the three regions into which the intestine of a sea-urchin larva is divided are constant whatever the size of the larva.

The following quotations will make Driesch's position clear. He says (1900, p. 397): "Dieses Faktum lehrt uns zugleich die *vollständige Proportionalität* der inneren Ausbildung bei Keimen aus isolirten Blastomeren im Vergleich zu Normalkeimen kennen: erstere sind durchaus ein verkleinertes Abbild letzterer. In meinen Betrachtungen über die Lokalisation morphogenetischer Vorgänge spielt die Wahrung der Proportionalität bei verkleinerten Gebilden bekanntlich eine grosse Rolle." Again in his *Organischen Regulationen* (1901, p. 176): "Das aber ergiebt als Schluss:

$$\frac{x}{g} = A^*.$$

Für eine bestimmte Organbildung bleibt also in jedem Experimentalfall das Verhältniss ihres Abstandes vom Ausgangsende der Messung zur Gesammtlänge konstant." Regarding the "constant" A, Driesch says (*loc. cit.*, p. 178): "In dem '*A*' *unserer Formel ist nämlich Dasjenige verkörpert, was seit Alters 'Substantialität der Form' genannt worden ist,* was man aber auch, mit aristotelischem Ausdruck, *Entelechie* nennen könnte. Die Formsubstantialität tritt nun in der Formel $x = g . A$ als in elementarer Weise massgebend für das Geschehen in jedem Falle auf." And again (*loc. cit.*, p. 179): "*Unsere Grösse* A *wird dem analog, was im Physikalischen eine Konstante ist.* Der Satz: 'dieses hier vor uns liegende äquipotentielle System (dieser Keim) hat die Entelechiekonstante A' heisst: wie gross das System auch sein mag, das Entwickelungsgeschehen an ihm muss in einer Weise vor sich gehen, dass eine endliche Konfiguration bestimmter Art und Proportionalität an ihm auftritt. Ebenso bleibt die Konstante eines homogenen Stückes Metall für elektrische Leitfähigkeit dieselbe, mag das Stück gross oder klein sein."

The point may be stated in its most general form in the following way: Let *AB*, *BC*, and *CD* (Fig. 6) be any three dimensions of an organism. Then according to the position maintained by Driesch the ratios $\frac{AB}{AD}$, $\frac{BC}{AD}$, $\frac{CD}{AD}$, etc., are each a constant regardless of the absolute size of the individual dimensions themselves. In other words, it is contended that these ratios are not sensibly correlated with the absolute size of the system. From this assumed independence Driesch deduces rather far-reaching generalizations, as the quotations show. But, as has been brought out above, when the matter is subjected to quantitative test it is found that, in the case of two protozoan forms at least, there is a sensible and definite correlation between such a ratio $\frac{AB}{CD}$ (Fig. 7) and the absolute size of the system. Now clearly the ratio $\frac{AB}{CD}$ is an index of the proportionality of the two chief dimensions of the body, or, in a word, of the shape of the body. It seems to me that the facts given demonstrate *that in Paramecium and Chilomonas size and form of body are correlated,* and hence, in so far, experience does not agree with Driesch's generalization. It is probable that the same thing will be found to be generally true. It has been demonstrated for the principal indices of the human skull by Miss Fawcett (1902) and Macdonell (1904). Unpublished material on other and widely different organisms gives the same result. If it holds generally that the proportionality of the parts and the absolute size of a differentiated system are sensibly correlated, it seems to me that the analysis on which Driesch's first "proof" of the "Autonomie der Lebensvorgänge" is based will have to be considerably modified.

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* Where x and g correspond to AB and AD in Fig. 6, below.

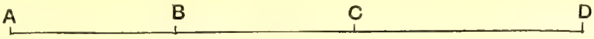

FIG. 6.

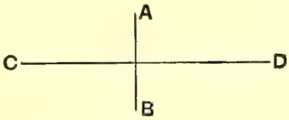

FIG. 7.

Summary.

A comparative study of variation and correlation in the flagellate Infusorian *Chilomonas paramecium* when living on the one hand under the optimum environmental conditions, and on the other hand under extremely unfavourable conditions, has led to the following results.

1. The individuals in the unfavourable environment are markedly smaller than those in an optimum environment.

2. The individuals under the two sets of conditions are significantly different in shape, those living under poor conditions being relatively narrower.

3. There is no marked difference in variability or correlation between the two groups, though there is a slight preponderance for both variability and correlation in the group living in the unfavourable environment.

4. The distribution of variation is skew in the case of the individuals from the optimum cultural condition, and symmetrical in the case of the other group.

5. The skewness is positive, or in other words, the majority of the population are *larger* than the modal individuals.

6. There is a considerable degree of correlation between length and breadth of body in *Chilomonas* (coefficients > ·6). The regressions between these characters are linear.

7. The values for the coefficients of variation and correlation in *Chilomonas* are of the same general order of magnitude as those which have been determined for other Protozoa.

8. There is a distinct correlation between the shape of the body and its absolute size in *Chilomonas*. The bearing of this result on Driesch's first "proof' of the "Autonomie der Lebensvorgänge" is discussed.

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THE NON-INHERITANCE OF SEX IN MAN.

By FREDERICK ADAMS WOODS, M.D.

The appearance of several recent articles summarizing our knowledge concerning sex determination has suggested the possibility of an inheritable influence in the distribution of the sex of offspring. According to this view there should be some families in which males predominate, and some in which females appear in exceptional numbers. Although not presenting satisfactory statistics this belief was held by Lorenz (**2**) (p. 364), Lenhossék (**1**) (p. 56), and Orschansky (**5**) (pp. 18, 126), who considered sex subject to hereditary influences. Orschansky (p. 126) states: "Als Hauptresultat unserer Beobachtungen über die Entstehung des Geschlechts beim Kinde: ergiebt sich, dass die Entstehung des einen oder des anderen Geschlechts in gewissen Grenzen eine erbliche morphologisch-physiologische Funktion des gesamten Organismus, und hauptsächlich der Sexualorgane der Eltern ist."

If it is true that a purely inherited tendency is of any moment whatever in governing sex distribution, then the parents of "fraternities" in which there is a marked departure from the normal proportions, should themselves belong to "fraternities" which, on the average, show something of the same departure. That this is not the case and that there is no correlation in sex-producing power between mother and daughter, or father and son, I believe to be conclusively proved by the following statistics.

I have used the records contained in Dr K. von Behr's "Genealogie der in Europa regierenden Fürstenhäuser. Zweite Auflage," Leipzig, 1870. This large and authoritative work contains excellent material for such a research. Within its pages is to be found the full genealogical tree of every reigning house in Europe; and the birth and sex of every infant born is recorded with the utmost care. I have collected a portion of my material from this book, and within certain rigid limits, have included all the individuals mentioned. Taking one family after another, I have started with the last generation, the first child of which was born before the close of the eighteenth century. A count was made of the number of males and of the number of females in this generation. I then looked up the record of the mother of these children. She, almost invariably, being also of royal blood, was to be found recorded somewhere in the book under the heading of the house from which she came. The sexes of children which *her* mother gave birth to were thus obtained, and were placed in the columns at the right of the columns containing the figures for the younger generation. Next, the sexes of the children in the father's generation were recorded and can be seen in the left-hand columns just below the children's (see Table I). This record was repeated for every generation back to the beginning of the seventeenth century. All the families, touched upon at all, have been studied completely, and are in general the same houses the records of which I used in a study "Mental and Moral Heredity in Royalty." These families are to be classified among the more famous branches of royalty, the genealogical and biographical records of which are seldom difficult to obtain even on the female side. Several families in von Behr's genealogy have been entirely unutilized in this research. I have omitted them merely to save time. They are such families as have made frequent alliances outside the strictly royal houses, and consequently one could not find the maternal records in von Behr. This omission should have no effect on the general averages.

In the illustrative table below we see the distribution of sex among the children of different fraternities for several generations. Thus the figures within the block for the Hapsburgs (page 208 of "von Behr") give us the history of the sex distribution in that house during two centuries. In the upper left-hand corner we see the figures 1 and 3. This means one male and three females were born in the last generation which this family produced prior to 1800 A.D. These children were Maria Theresa, her one brother and two sisters. Their mother was Elizabeth of Brunswick who was found to have been one of four sisters. This fact is recorded in the figures 0 and 4 just to the right of 1 and 3. Their father was Charles VI of Austria, of a family of three boys and eight girls, which fact is recorded just below the figures 1 and 3. The ancestry of Charles VI's fraternity of 3 boys to 8 girls was next taken up and so on back to the parents of the fraternity reading 6 and 9, which was the most ancient studied. In the first three fraternities 1–3; 0–4; and 3–8, we see an apparent inherited tendency towards the birth of girls. Our averages and correlation coefficient show, however, that this is but a meaningless accident.

In order to obtain material sufficient to give me a low probable error, I added to the facts drawn from von Behr, some statistics taken from Burke's "Peerage and Baronetage," 1895. Here I have utilized the records of the two most recent generations, taking first the numbers of males and females in the very latest generations, and compared these fraternities with the fraternities of their fathers and mothers. I have taken only those families in which the eldest child was born prior to 1880. I have also left out of consideration those fraternities whose mothers were not also born in the peerage, because it would be very laborious to look up the ancestry of such mothers. It is really surprising how many peers of to-day marry the daughters of commoners, making it often necessary to turn over many pages of Burke to find a case where the maternal ancestry is recorded in this same book of the *élite.*

TABLE I.

Sample Table from von Behr's "Genealogie."

von Behr page	Distribution of sex among the children		Distribution of sex among the mother's fraternity	
	♂	♀	♂	♀
146	4	3	3	5
	2	0	7	6
	3	2	2	3
	2	3	10	4
	2	3	2	2
	4	0	—	—
147	4	0	4	4
	5	2	4	1
	13	6	2	1
	2	6	5	7
	12	6	0	1
	10	1	6	4
	2	3	6	5
	4	0	—	—
150	5	5	3	4
	5	2	9	6
	4	4	4	9
	3	5	3	4
	10	1	—	—
155	5	5	1	5
	4	5	4	6
	4	8	3	3
	6	4	—	—
158	4	3	8	7
	2	4	1	5
	2	2	5	8
	4	9	2	6
	1	1	—	—
	1	4	2	9
	4	6	5	7
	6	4	—	—
166	5	4	1	3
	7	3	2	2
	2	2	—	—
	5	8	3	3
	2	2	—	—

von Behr page	Distribution of sex among the children		Distribution of sex among the mother's fraternity	
	♂	♀	♂	♀
168	8	5	3	3
	5	2	2	2
	6	6	2	5
	6	8	—	—
172	2	2	4	3
	8	4	2	3
	5	1	—	—
	5	4	7	3
	9	6	2	4
	2	1	5	5
	1	1	—	—
184	3	4	3	2
	1	1	1	1
	2	1	—	—
185	3	0	3	2
	2	2	—	—
	1	7	2	4
	3	5	—	—
187	3	3	5	2
	1	2	4	1
	1	1	5	4
	1	7	5	3
	2	1	2	1
	2	0	—	—
188	2	2	6	6
	5	4	7	8
	3	8	—	—
	3	0	5	5
	3	0	5	3
	3	3	6	5
	2	0	4	4
	3	3	—	—
190	8	6	1	2
	6	7	7	8
	4	3	—	—
191	6	6	8	6
	7	10	5	11
	6	7	—	—

von Behr page	Distribution of sex among the children		Distribution of sex among the mother's fraternity	
	♂	♀	♂	♀
192	1	0	1	2
	1	2	—	—
	1	0	4	6
	3	6	5	3
	4	6	1	3
	2	1	—	—
192	2	0	1	7
	4	1	3	6
	4	3	4	6
	3	0	—	—
195	2	3	0	1
	2	1	—	—
196	2	6	1	1
	3	4	4	7
	3	5	1	1
	2	3	1	4
	1	2	—	—
199	0	1	6	5
	3	0	6	2
	1	7	3	4
	5	4	—	—
201	6	3	2	4
	7	3	1	4
	5	3	1	3
	4	5	3	4
	6	2	—	—
203	3	4	4	9
	3	6	8	6
	4	3	1	7
	5	1	2	7
	5	4	9	8
	4	3	—	—
208	1	3	0	4
	3	8	9	8
	2	2	4	4
	4	3	6	4
	6	9	5	2
	4	11	—	—

TABLE II.

Sample Table from Burke's "Peerage." Distribution of the sexes. (Youngest Generations.)

Burke's Peerage 1895 page	Distribution of sex among the children		Distribution of sex among the mother's fraternity		Distribution of sex among the father's fraternity		Burke's Peerage 1895 page	Distribution of sex among the children		Distribution of sex among the mother's fraternity		Distribution of sex among the father's fraternity	
	♂	♀	♂	♀	♂	♀		♂	♀	♂	♀	♂	♀
1	6	2	2	1	6	7	*304*	1	0	3	3	2	3
8	3	2	4	3	3	3	*308*	2	3	0	1	4	7
9	5	5	2	4	2	3	*308*	4	3	2	6	4	7
29	1	5	2	4	3	4	*310*	1	3	4	1	4	8
30	2	8	5	5	3	4	*316*	4	3	5	8	2	7
35	4	6	7	7	1	2	*323*	3	1	0	1	2	3
51	5	7	4	7	2	1	*337*	3	6	2	5	3	2
58	1	3	2	2	2	3	*343*	4	3	1	6	5	6
71	4	3	7	8	1	0	*344*	5	3	3	4	5	1
109	5	3	3	2	1	1	*344*	3	5	2	5	3	0
114	5	1	7	3	1	6	*347*	6	3	4	5	1	1
119	5	9	5	6	3	2	*355*	6	1	2	4	1	6
144	1	5	4	7	5	4	*366*	2	0	0	1	6	1
154	4	1	2	4	4	4	*384*	3	5	4	3	3	2
170	4	2	6	5	3	4	*402*	4	0	0	1	2	4
180	0	2	4	3	2	3	*403*	4	5	7	6	2	1
180	6	2	3	2	2	5	*411*	8	2	4	4	2	1
181	2	0	2	4	1	0	*414*	6	1	6	3	1	1
182	1	2	4	3	6	4	*416*	0	3	2	3	1	2
199	5	2	6	7	4	3	*417*	6	2	1	4	2	4
217	1	2	8	2	3	4	*434*	2	0	4	2	1	7
222	3	4	2	5	5	3	*440*	4	2	2	4	5	0
232	1	3	2	3	4	6	*447*	2	3	4	1	8	2
237	1	0	7	5	4	0	*470*	1	5	4	7	1	3
250	6	5	4	6	1	0	*471*	0	3	3	3	1	4
270	3	4	1	2	3	4	*479*	1	3	3	7	1	1
271	2	1	3	5	3	2	*483*	4	2	6	2	5	2
274	0	1	3	2	2	1	*513*	1	3	0	3	1	0
282	1	3	3	3	3	1	*557*	8	6	5	6	4	6

Following the tables recording these facts are the records of the distribution of sex obtained by the same method, for the next to the latest generations, in the male lines; and parallel to them the records of the distribution of sex in the fraternities of their fathers and mothers.

I then sought to find a correlation in the distribution of sex in the fraternities of all the children, and the distribution of sex in the fraternities to which their parents belonged.

I have divided all the fraternities into two classes, first those *with* an excess of males, and second those *without* an excess of males. By this means I could utilise those cases which frequently occur, in which the proportion of males and females is equal.

The four-fold correlation table shows us at once, that the inheritable influence in the tendency to produce an excess of males must be very slight. Working it out carefully we find the coefficient, r, practically zero, and well within the probable error.

Parental.

		Fraternities showing an excess of males	Fraternities showing no excess of males	Totals
Filial.	Fraternities showing an excess of males	291	423	714
	Fraternities showing no excess of males	303	448	751
	Totals	594	871	1465

$h=\cdot 2392224$, $H=\cdot 3876579$,

$k=\cdot 0316591$, $K=\cdot 3987424$.

This gives the equation :

$$\cdot 006628=r+\cdot 003787r^2+\cdot 15698r^3+\ldots \text{ the root of which is } r=\cdot 0066\pm\cdot 0305.$$

I have also selected those cases in the foregoing tables in which an excess of males happened on both sides of the house in the ancestral (parental) generations, and have sought to find if here an excess of males might not be shown among their children. Instead of an excess of males there were but 334 males against 351 females born in such families. Similarly the families with an excess of females in both sides of the ancestry produced but 357 female children against 402 males.

Thus we may conclude that the determination of sex, in man at least, can be shown to be unaffected by hereditary influence. This agrees with the statistical conclusion of Simon Newcomb (4) obtained by a different method.

Nor does it seem probable that any Mendelian principles control the determination of sex in man, for then we should expect some correlation in the distribution of the sexes in successive generations due to the union of dominants with each other, and also due to the union of recessives with each other.

These statistical proofs which lead us to a definite conclusion of non-inheritance have an important bearing upon several theories regarding the determination of sex. If sex is largely determined by agencies acting upon the young and supposedly indifferent embryo, even if these were largely external (nourishment, temperature, etc.), the constitutional peculiarity of the mother would have, under ordinary circumstances, a large share in forming these differences of environment. As we know that constitutional peculiarities are to a measurable degree inherited and capable of giving us a correlation coefficient, and as we here find no such coefficient, we see an argument in favour of the view that sex is not determined during gestation.

There are moreover many other considerations which lead to the belief that sex is not influenced after impregnation, but is already determined at that time or before (conf. Lenhossék (**1**) and Morgan (**3**)). Many writers who favour this theory nevertheless believe that parental organisms have considerable influence on the proportion of males to females, although this influence is exerted prior to impregnation. This question is discussed in its many relations in Orschansky (**5**). His statistics are, however, far from convincing. On page 122 we find the following: "Die Beobachtungen an kranken Familien ergeben die augenscheinlich paradoxe Thatsache, dass ein Erzeuger mit der schwächsten Konstitution eine grössere Neigung als ein gesunder äussert, sein Geschlecht auf seine Kinder zu übertragen."

If it be true that sex is dependent on any constitutional or nutritional influence exerted during the formation or ripening of the ova or spermatozoa, then like other constitutional differences it should be inherited. My own figures tend to show that neither the soma of the father nor the soma of the mother have any influence, at least in man, in the determination of sex, nor is the proportionate distribution of sex in any degree subject to hereditary influence.

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ON THE INHERITANCE OF THE SEX-RATIO.

BY DAVID HERON, M.A.

IT has been suggested that the approach to equality in male and female births is an illustration in some mysterious manner of Mendel's theory of heredity. Observers have actually counted the number of males and females born in divers species with the conception that the approach to equality thus rendered manifest illustrates in some way Mendelian principles. I am not prepared to say it does not, because I have failed to grasp the manner in which those principles are applied to this case. If the demonstration depends, however, on the equality of the male and female births, their sensible inequality* in the case of man requires some further explanation; it is a case wherein environment or *a priori*, perhaps, race causes permanent and fairly constant deviations from equality. The aim of the present paper is to show that, as far as the writer can judge, there is no inheritance, Mendelian or other, of the sex-ratio. So far it confirms the results of Dr F. A. Woods stated in the previous paper, but the method of approaching the problem differs from his. No assumption is made as to the existence of a Gaussian distribution for the frequency, and the sex-ratio for the family of each individual is directly calculated and tabled. The paper further deals with the case of horse as well as man. There is no difficulty in extending the investigations to cattle and dogs from the herd and studbook returns, but the negative results provided by two such different species seem sufficient to demonstrate that the non-inheritance of sex is fairly widespread.

The material is the following:

(i) Data from a series of schedules on the size of families issued by Professor K. Pearson. Unfortunately this material proved less ample for this special purpose than we had anticipated. For although marriages must have existed at least 15 years in both generations for a schedule to be filled in, it happened in a very large number of the cases that the families in *both* generations did not provide the number (four) of children which seemed the least upon which a determination of sex-ratio could be made. Only 348 cases were taken from this source.

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* See C. J. and J. N. Lewis: *Natality and Fecundity*, 1906.

(ii) Data drawn from *The Whitney Family of Connecticut and its Affiliations* (1649—1878), by S. Whitney Phoenix, 3 vols., Newport, 1878. This work contains a very great deal of genealogical information with regard to American families connected nearly or remotely with the Quaker Family of Whitney. In this case no family in both generations of less than four members was used to determine the sex-ratio. 2197 such families were extracted.

(iii) Data drawn from *The General Studbook*, 20 vols., J. E. and T. P. Wetherby. In this case 1000 thoroughbred mares were taken at random and the sex-ratio of their produce and that of their dam calculated. Both mother and daughter must have had at least eight foals to be included in the list.

Some word must be said as to what has been understood by sex-ratio in the course of the work. It has been taken to represent the fraction: number of male offspring divided by total number of offspring. This point must not be forgotten in the following investigation. Thus, in dealing with the father's sibship, there must always be *one* male, and, considering the average size of human families, it is extremely unlikely that the sex-ratio as defined above should fall between ·00—·05, it would in fact require at least 20 children. Again, in the mother's sibship there is always one female, and thus it is unlikely that the sex-ratio should fall between ·95 and 1·00; this would again require at least 20 children. It will be seen that in the sex-ratio of the offspring's sibship we have a tendency for the frequency to lump up in these terminal groups, although their range is only half that of the other elementary frequency groups. This is almost entirely due to families in which there are no males or no females. Undoubtedly certain individuals tend to produce offspring all of one sex, either *per se* or because they are mated with a special type of consort. The latter reason seems the more probable, because, in the case of thoroughbred horses, where the matings change there appears to be no similar tendency for produce all of one sex to occur. A special study of cases in man and other animals in which for the *same* mating there is constancy of sex would be very instructive. It is probably due, as the tendency shows no sign in our tables of inheritance, to some physical characteristic of the individual which remains wholly dormant until it is affected by a corresponding characteristic in the mate. In working the moments and products, the frequency has been centered at the middle of the elementary range. This is probably not true in the case of the extreme elements in the offsprings' sibships in Tables I. and II., but the actual centering was found to have little influence on the correlations, and made no modification in the fundamental significance of the results. Sheppard's corrections were used.

In Tables I. and II. the sex-ratio of a family is correlated with that of the father's and mother's sibships respectively. It may be said: Why not, when dealing with the latter sibship, leave out father and mother successively in calculating the sex-ratio? A somewhat similar method has been adopted by Francis Galton for another purpose, and is justified in his case if we may assume that the chance of male or female is practically one-half for each family. It does

TABLE I.

Correlation of Sibships of Father and Offspring. Whitney Data.

Sex-Ratio of Offspring's Sibship.

Sex-Ratio of Father's Sibship.	·00— ·05	·05— ·15	·15— ·25	·25— ·35	·35— ·45	·45— ·55	·55— ·65	·65— ·75	·75— ·85	·85— ·95	·95—1·00	Totals
·00— ·05	—	—	—	—	—	—	—	—	—	—	—	—
·05— ·15	—	—	—	—	1	—	1	—	—	—	—	2
·15— ·25	—	1	4	0·5	5	5·5	7·5	3·5	2	—	2	31
·25— ·35	1	1	6	6·5	16	12·5	5·5	6	7·5	—	2	64
·35— ·45	2	3	14	12	28	39	30	19	11	6	6	170
·45— ·55	—	2	17	23	31	50	34	27	24	4	3	215
·55— ·65	6	4	23·5	33·5	40	46	41	27	35	3	7	266
·65— ·75	4	6	15·5	18	31	40·5	31	29·25	22·25	3	7	207·5
·75— ·85	—	1	8	9·5	17	19·5	17	10·75	6·75	—	7	96·5
·85— ·95	1	1	4·5	7·5	5	11	12	11·5	2·5	3	2	61
·95—1·00	—	—	0·5	4·5	7	8	6	6·5	4·5	2	5	44
Totals	14	19	93	115	181	232	185	140·5	115·5	21	41	1157

TABLE II.

Correlation of Sibships of Mother and Offspring. Whitney Data.

Sex-Ratio of Offspring's Sibships.

Sex-Ratio of Mother's Sibship.	·00— ·05	·05— ·15	·15— ·25	·25— ·35	·35— ·45	·45— ·55	·55— ·65	·65— ·75	·75— ·85	·85— ·95	·95—1·00	Totals
·00— ·05	—	—	1·5	0·5	2	1	1	0·5	0·5	—	—	7
·05— ·15	2	—	2	4	4	5	2	3	5	—	2	29
·15— ·25	—	—	9	13	9·5	18	12	8·5	13	1	4·5	88·5
·25— ·35	4	1	9·5	11·5	17·5	36	21	18·5	15	2	5·5	141·5
·35— ·45	10	3	18·5	21·5	39	54	44	27	22	6	5	250
·45— ·55	7	1	22·5	21·5	23	37	44	22	23	2	9	212
·55— ·65	5	—	15·5	17·5	29	36	32	23	21	1	10	190
·65— ·75	1	0·5	3·25	9·25	16	15	12	11·25	4·25	1·5	4·5	78·5
·75— ·85	—	0·5	2·25	4·25	6	7	5	2·75	4·75	0·5	0·5	33·5
·85— ·95	—	—	0·5	1·5	3	3	—	2	—	—	—	10
·95—1·00	—	—	—	—	—	—	—	—	—	—	—	—
Totals	29	6	84·5	104·5	149	212	173	118·5	108·5	14	41	1040

not *a priori* seem justified in the present investigation, for one of the points involved is, admitting the average sex-ratio for the race to be not very far from ·5, does this ratio vary significantly from individual family to individual family, as we should expect if it were inherited? Thus, if we leave mother or father out in calculating the sex-ratio of their sibship, we may be diminishing or emphasising the possibly slight tendency of that sibship to femininity or masculinity. The exclusion of even one individual can produce very sensible effects in the case of the small families which occur with human beings, although it is of less significance in the case of horses or many other mammals. It will thus be seen that the vertical and horizontal means and standard deviations of our Tables I. and II. could not be expected to be in accordance. To test whether this peculiarity has any influence on the result, Table III. was formed. This gives the correlation between sibships in the filial generation and *all* parental sibships. It would seem from this table that there really exists a marked difference between the distribution of the sex-ratio in the two generations, families which tend wholly or largely to one sex being much under-represented in the mated population.

TABLE III.

General Correlation, Parental and Filial Sibships. Whitney Family.

Sex-Ratio of Filial Sibships.

Sex-Ratio of Parental Sibships.	*·00— ·05*	*·05— ·15*	*·15— ·25*	*·25— ·35*	*·35— ·45*	*·45— ·55*	*·55— ·65*	*·65— ·75*	*·75— ·85*	*·85— ·95*	*·95—1·00*	Totals
·00— ·05	—	—	1·5	0·5	2	1	1	0·5	0·5	—	—	7
·05— ·15	2	—	2	4	5	5	3	3	5	—	2	31
·15— ·25	—	1	13	13·5	14·5	23·5	19·5	12	15	1	6·5	119·5
·25— ·35	5	2	15·5	18	33·5	48·5	26·5	24·5	22·5	2	7·5	205·5
·35— ·45	12	6	32·5	33·5	67	93	74	46	33	12	11	420
·45— ·55	7	3	39·5	44·5	54	87	78	49	47	6	12	427
·55— ·65	11	4	39	51	69	82	73	50	56	4	17	456
·65— ·75	5	6·5	18·75	27·25	47	55·5	43	40·5	26·5	4·5	11·5	286
·75— ·85	—	1·5	10·25	13·75	23	26·5	22	13·5	11·5	0·5	7·5	130
·85— ·95	1	1	5	9	8	14	12	13·5	2·5	3	2	71
·95—1·00	—	—	0·5	4·5	7	8	6	6·5	4·5	2	5	44
Totals	43	25	177·5	219·5	330	444	358	259	224	35	82	2197

In Table IV. another method of investigating the problem is considered, based also on different data. A sort of mid-parent was used. A joint-parental sibship was formed by combining mother's and father's sibships together and taking the sex-ratio for the total array. The result is precisely the same as in the previous cases.

In Table V. we have a wholly different method of approaching the problem. Here the sex-ratio of the produce of a thoroughbred mare—often reaching 14 to 18 foals—has been determined and correlated with the produce of one of her fillies selected at random. In this case the produce is usually due to a very considerable number of sires, or forms a half-sibship, some individuals, however, being possibly whole siblings. This method enables us to determine whether the individual has any tendency to produce one or other sex which is inherited by

TABLE IV.

Correlation of Joint Parental with Filial Sibships. Schedules.

Sex-Ratio of Filial Sibship.

Sex-Ratio of Joint Parental Sibships.	·00— ·05	·05— ·15	·15— ·25	·25— ·35	·35— ·45	·45— ·55	·55— ·65	·65— ·75	·75— ·85	·85— ·95	·95—1·00	Totals
·00— ·05	—	—	—	—	—	—	—	—	—	—	—	—
·05— ·15	—	—	—	—	—	—	—	—	—	—	—	—
·15— ·25	—	—	0·5	0·5	1	2·5	2	1·5	1	—	—	9
·25— ·35	1	1	4	4	—	8·5	4·5	2·5	1	1	—	27·5
·35— ·45	2	1	2·5	6·5	12	11	13·5	2·5	3·5	—	2	56·5
·45— ·55	1	3	7·5	9·5	26	18	17·5	16·5	10·5	1	1	111·5
·55— ·65	1	2	4·5	6·5	15	22	16	18	5	2	—	92
·65— ·75	2	1	0·5	3·5	5	9	5	3	3·5	1	1	34·5
·75— ·85	—	—	0·5	4·5	3	3·5	1·5	2	0·5	—	1	16·5
·85— ·95	—	—	—	—	—	0·5	—	—	—	—	—	0·5
·95—1·00	—	—	—	—	—	—	—	—	—	—	—	—
Totals	7	8	20	35	62	75	60	46	25	5	5	348

TABLE V.

Correlation of Sex-Ratios of Mother and Daughter Mares' Produce. Thoroughbred Horses.

Sex-Ratio of Mother's Produce.

Sex-Ratio of Daughter's Produce.	00— ·05	·05— ·15	·15— ·25	·25— ·35	·35— ·45	·45— ·55	·55— ·65	·65— ·75	·75— ·85	·85— ·95	·95—1·00	Totals
·00— ·05	—	—	0·5	1·5	1	1	—	—	—	—	—	4
·05— ·15	—	—	0·5	1·5	3	6	2	—	—	—	—	13
·15— ·25	—	1·5	6	7	11	8	7	5	1	—	—	46·5
·25— ·35	—	1·5	10·5	20·5	23	35	30	12	3	1	—	136·5
·35— ·45	2	9	9	25	58	60	41	13	5	—	—	222
·45— ·55	—	6	19	27	61	72	47	20	5	—	—	257
·55— ·65	—	4	12	25	51	52	38	11	6	—	—	199
·65— ·75	—	1	3	14	18	21	19·5	5	3	1	—	85·5
·75— ·85	—	1	1	3	6	10	6·5	2	—	—	—	29·5
·85— ·95	—	—	—	1	2	2	—	1	—	—	—	6
·95—1·00	—	—	—	—	1	—	—	—	—	—	—	1
Totals	2	24	61·5	125·5	235	267	191	69	23	2	—	1000

her offspring, and is, perhaps, more satisfactory than the human determination. Reducing this material, we obtained the following results:

TABLE VI.

Mean and Standard Deviation of Sex-Ratios.

	Group	Mean	Standard Deviation
1	Father's Sibship, Man	·589 ± ·004	·178 ± ·002
2	Mother's Sibship, Man	·456 ± ·003	·167 ± ·002
3	All Parental Sibships, Man	·526 ± ·003	·185 ± ·002
4	Filial Sibship, Table I., Man	·522 ± ·004	·208 ± ·003
5	Filial Sibship, Table II., Man	·520 ± ·005	·218 ± ·003
6	Filial Sibships, Table III., Man ...	·521 ± ·003	·210 ± ·002
7	Filial Sibships, Table IV., Man ...	·504 ± ·007	·193 ± ·005
8	Joint Parental Sibships, Table IV., Man	·521 ± ·005	·130 ± ·003
9	Mare's Produce, Mother	·463 ± ·003	·148 ± ·002
10	Mare's Produce, Daughter	·478 ± ·003	·151 ± ·002

Now, if we examine this table, we cannot in the case of thoroughbred horses assert that any difference exists in the variability of the sex-ratio for the two generations. But in the case of man there certainly is a significant difference in the variability. While there is no significance in the difference of the variabilities denoted by the row numbers 4, 5, and 6, and possibly not in 7, there is a difference more than six times the probable error of the difference between these variabilities and that of 3. There is, however, no difference in type between 3, 4, 5, 6, 8, and possibly, but not certainly, 7*. These figures demonstrate the point referred to above, that in the free mating of man, families with a preponderance of female or male elements are not drawn upon equally with families in which the sexes are more equally balanced. In the controlled mating of horses this result is not apparent.

We have already noted that in the sibships which are not selected so as to have at least one male or one female, the type is fairly constant and gives a sex-ratio of about ·522, which corresponds to 109 male births as compared with 100 female births, a quite good result. We next ask how does this agree with the values found for sibships which must have at least one male or female? Let n be the average number in a sibship, and s be the sex-ratio. Then if we choose sibships in which there is at least one male, we might expect the sex-ratio to be

$$\{1 + (n - 1)\,s\}/n,$$

and that for sibships with at least one female to be

$$(n - 1)\,s/n.$$

---

* The data for 7 include a Cornish fishing village where the sex-ratio is far more nearly one of equality than elsewhere in this country; owing to the persistence of large families in this district, it therefore figures disproportionately in the results.

Equating these respectively to ·589 and ·456, the sex-ratios for paternal and maternal sibships, we find:

$$n = 7{\cdot}62 \text{ and } s = {\cdot}526.$$

The latter value is precisely the value found for all sibships of the parental generation. The former should represent the average number in a sibship of the parental generation. It cannot be very far from its true value, because all sibships without at least one male (or it may be one female) have been by the nature of the case excluded, and further, no sibship has been used with fewer than four members. It will thus be seen that our human data are in good accordance with each other.

So far as we can judge, in the second generation of thoroughbred horses under consideration there was a preponderance of mares born, the sex-ratio being ·478, and differing from ·500 by at least seven times the probable error. In the first generation, since there must be one filly in the produce at least, we have

$$(n-1)\, s/n = {\cdot}463,$$

and if n lie between 10 and 15 as it does, this gives $s = {\cdot}5$ within the probable error. In other words, the sex-ratio between the two generations appears to have fallen from equality to about ·48, a substantial alteration.

Turning now to the main portion of the present enquiry, we have:

TABLE VII.

Correlation between Sex-Ratios in Successive Generations.

Nature of Sibships	Correlation
Sibships of Father and Offspring, Man	·053 ± ·020
Sibships of Mother and Offspring, Man	·001 ± ·021
Sibships of Parent and Offspring, Man...	·021 ± ·014
Joint Parental Sibship and Offspring, Man	·043 ± ·036
Produce of Mother and Daughter, Thoroughbred Horse	·034 ± ·021

It is true that all these correlations are positive, but not one of them is definitely significant, having regard to its probable error. Thus on rather wider data—in horse as well as in man—Dr Woods' position is confirmed; there is no inheritance, or at least no sensible inheritance, of sex. The persistent and sensible differences from ·5 which occur in various races for the sex-ratio are therefore not racial in the sense that they are an inherited characteristic of the race; they must be in some manner associated with environment, nutrition, or habit. They appear to be a more universal, if less marked, result of such causes as lead certain species which usually reproduce parthenogenitively to occasionally reproduce sexually. It is conceivable that the sex-ratio of produce may not exhaust all the characters associated with an individual which are not subject to the general rule of inheritance.

A SECOND STUDY OF THE ENGLISH SKULL, WITH SPECIAL REFERENCE TO MOORFIELDS CRANIA.

By W. R. MACDONELL, LL.D.

(1) *Introductory.*

I NOW publish the detailed measurements of the series of English (Moorfields) skulls to which reference was made *passim* in my paper in *Biometrika*, Vol. III. pp. 191—244. The collection is in the possession of Professor G. D. Thane, of University College, London, and I have again to thank him very cordially for granting my fellow-workers and myself every facility for measuring and studying the skulls. I have also to express my gratitude to him for the great aid he has given in preparing the description of the anatomical peculiarities of the skulls provided in the "Remarks" to my Tables of Measurements. The collection is much smaller than the Whitechapel series, the subject of my former paper; it is too small, for instance, to allow of a satisfactory determination of coefficients of correlation, and I have therefore not worked them out except in two or three cases; but in other respects this series is quite as interesting as the former one. The preservation of the crania for scientific purposes was due in the first place to the energy of Mr S. Jacob, at that time working in the Biometric Laboratory at University College, London. Only an Indian appointment prevented him from carrying out the biometric investigation of the material, which I then undertook, starting *de novo* to avoid the influence of personal equation.

(2) *Material and History of the Site.*

Professor Karl Pearson and I examined the site together, and compared the old maps, and he has kindly drawn up for me the following notes. We have to thank Mr Welch, of the Guildhall Library, Mr Wood-Hill, Engineer of the North London Railway, and the staff of the Map and Print Departments of the British Museum, for assisting us in our inquiry.

The problems as to the date and mode of interment of the Moorfields remains are, as in the case of the Whitechapel bones, rendered very complex by the fact that no proper archaeological investigation was made at the time of their discovery. The remains were found in excavating for a street latrine, since constructed, at the West End of Liverpool Street, and were already collected into heaps before any complete investigation could be made of them *in situ**. The bones were found uncoffined and apparently lying in great disorder. In the Report of the Medical Office of Health (City of London, No. 61, 1903) it is suggested that the very large number of skeletons which were found when the Broad Street Station of the North London Railway was built may have been collected and reburied at the place where the excavations for the underground latrine were made in 1903. This solution of the problem does not seem to me probable, for the following reasons: That even if Liverpool Street were broadened at the building of the station, the bones were discovered in the middle, or south of the middle, of the existing street; it is extremely improbable that exhumed bones would have been reinterred under an existing thoroughfare, or that the permission to place them under the newly made part of such a thoroughfare would have been given. It is far more probable that the roadway was carried, whenever it was broadened, across an existing deposit of human remains. Now we know that Bethlem Burial Ground once occupied the sites of Broad Street Station and of the station yard. It is so marked on the large scale modern ordnance map of this part of the City. It would therefore be reasonable to suppose that the original burial ground extended to the centre of the present Liverpool Street, and that on widening that street a portion of the old burial ground was covered by the roadway. Stow remarks, concerning Bethlem Burial Ground†:

> "In the yere 1569. Sir Thomas Roe Merchant Taylor Mayor, caused to bee inclosed with a "wall of bricke, about one acre of ground, being part of the said Hospitall of Bethelem, to wit, on "the west, on the bancke of deepe ditch, so called, parting the said hospitall of Bethlem from the "More field: this he did for burial, in ease of such parishes in London as wanted ground, "convenient within their parishes. The Ladie his wife was there buried (by whose persuasion "he inclosed it) but himself borne in London, was buried in the parish church of Hackney."

Now it might be thought that the exact position and dimensions of a burial ground of this importance could hardly fail to be known, but unfortunately no plans or title-deeds seem to exist in the City Archives, and we are thrown back upon the evidence of the maps of the City and its environs at different dates. Unfortunately, most of these maps are very diagrammatic in character, few are drawn even approximately to scale‡, and even such an important map as Ogilby's of 1677 is quite unreliable for this district, as far as giving the accurate dimensions of streets and intervening plots is concerned. The first map which seems at all accurately drawn to scale with correct angles and capable by proper reduction of being fitted fairly closely to the modern ordnance map is Rocque's of 1746.

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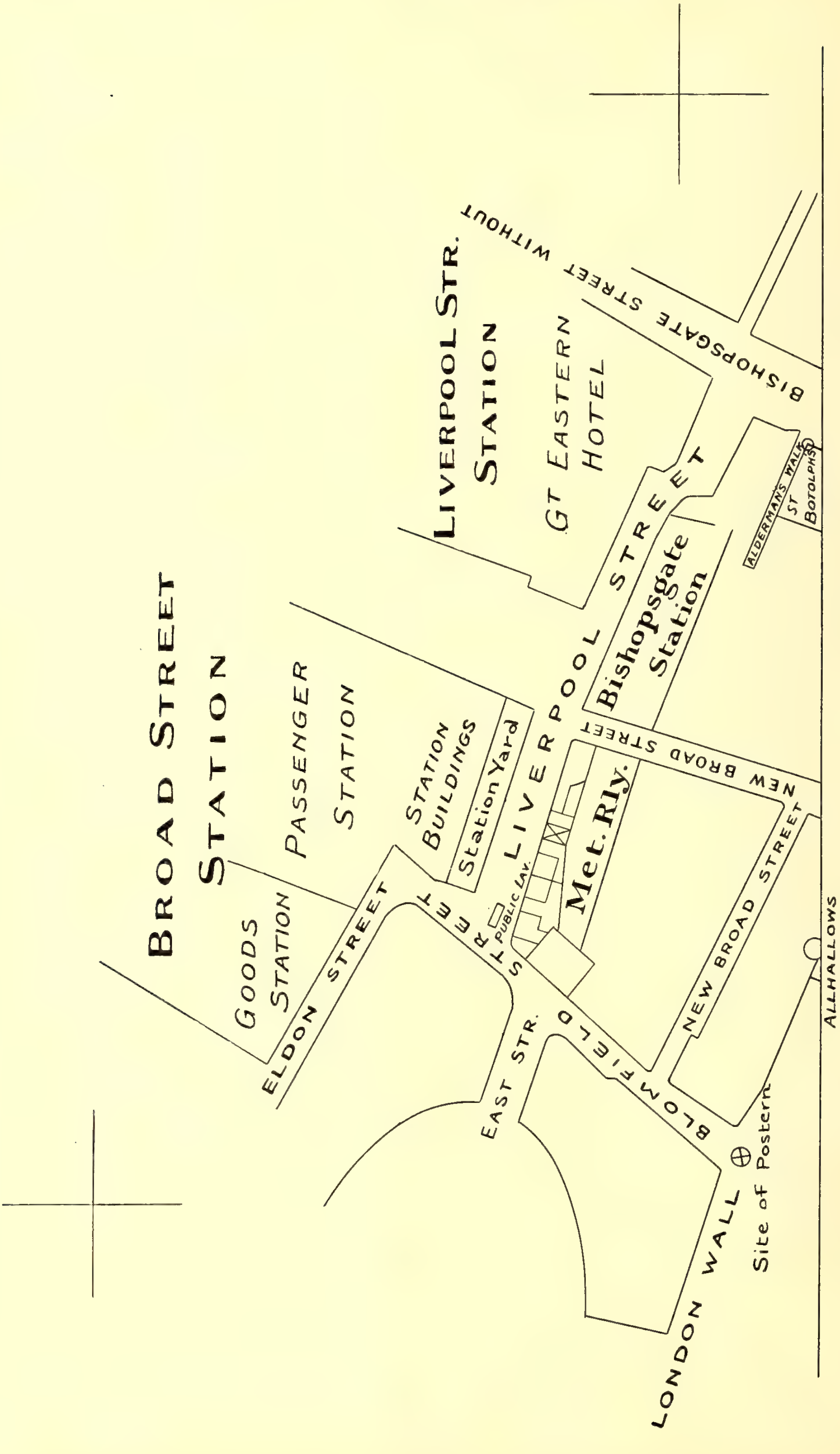
* A brief Act of Parliament ought to be passed compelling all building operators to at once summon a local officer, and a competent archaeologist, before proceeding further, when antiquities of any kind are reached in excavating.

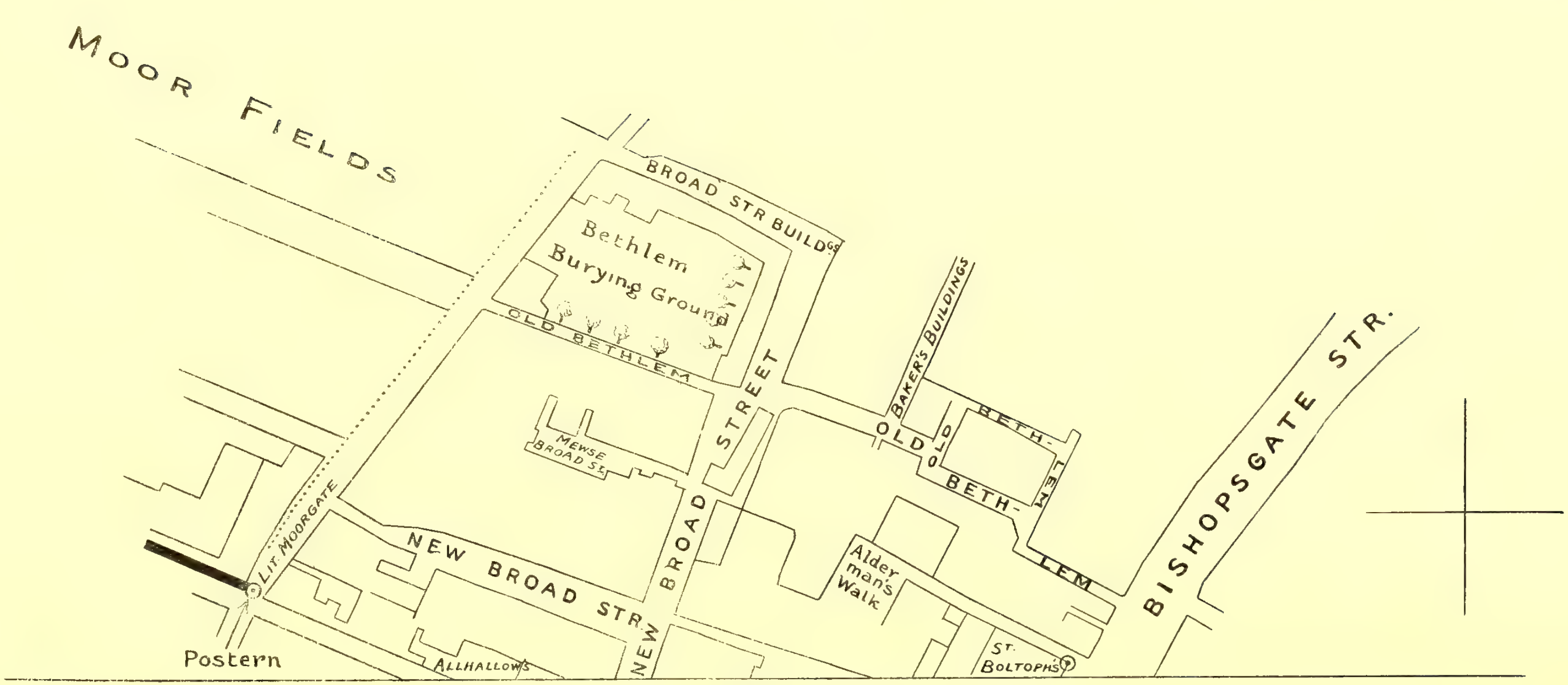
† *A Survay of London*, Octavo Edition, 1599, pp. 127-8.

‡ If different pairs of definite base points be taken and two maps reduced to a common scale, the fit, or want of fit, is often wholly different.


BROAD STREET STATION
GOODS STATION
PASSENGER STATION
STATION BUILDINGS
Station Yard
LIVERPOOL STR. STATION
GT EASTERN HOTEL
BISHOPSGATE STREET WITHOUT
LIVERPOOL STREET
Bishopsgate Station
ALDERMANS WALK
ST BOTOLPHS
NEW BROAD STREET
Met. Rly.
PUBLIC LAV.
ELDON STREET
EAST STR.
BLOMFIELD ST
NEW BROAD STREET
ALLHALLOWS ON THE WALL
Site of Postern
LONDON WALL

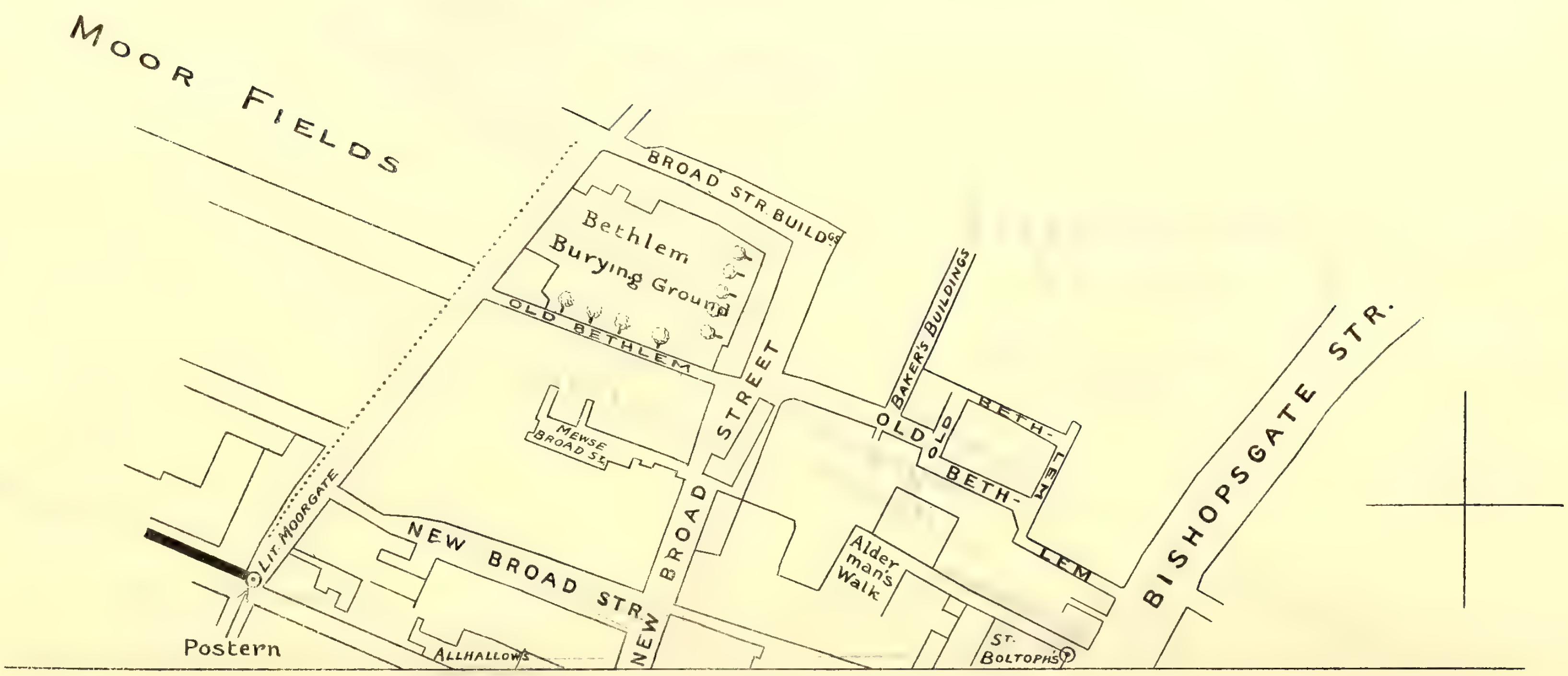
Reduced from 60 inch Ordnance Map.

This map is to superpose map on p. 88 of Biometrika, Vol. v, *Parts I and II, the crosses registering with those below.*


Moor Fields
Broad Str Build^{gs}
Bethlem Burying Ground
Old Bethlem
Baker's Buildings
Old Beth-lem
Old Beth-lem
Bishopsgate Str.
Broad Street
Mewse Broad St.
Lit. Moorgate
New Broad Str.
New Broad Str.
Alderman's Walk
St. Boltophs
Allhallows
Postern

Traced from Rocque's Map of Oct. 1746.

This map is to superpose map on p. 88 of Biometrika, Vol. v, *Parts I and II, the crosses registering with those below.*


Moor Fields
Broad Str. Build^gs
Bethlem Burying Ground
Old Bethlem
Baker's Buildings
Bishopsgate Str.
Old Beth-lem
Old Beth-lem
Broad Street
Mewse Broad St.
Alder man's Walk
New Broad Str.
Lit. Moorgate
Postern
Allhallows
St. Boltophs

Traced from Rocque's Map of Oct. 1746.

In Rocque's and earlier maps the present Liverpool Street is termed *Old Bethlem*, and this street runs from the modern Blomfield Street, then bounding Moorfields, to the site of the original Bedlam. Now if Rocque's map and the Ordnance Survey be reduced to a common scale,—and in doing this we have taken the north-east corner of St Botolph's Church and the old Moorfields postern in the city wall, which are marked on both maps—it will be found, as shown in the accompanying reproduction, that Old Bethlem coincided with the southern half of the modern Liverpool Street, and that the site of the latrine excavation was immediately on the left of the entry into Old Bethlem from Moorfields. If then, the bones were from interments in Sir Thomas Roe's Burial Ground, that ground must originally have extended to the corner where the centre line of the Liverpool Street of to-day runs into Blomfield Street. The available maps appear to provide no confirmation of this view. It is true that maps of the 18th century give most diverse forms to the ground, and there can be little doubt that in the latter half of that century and the beginning of the next, buildings encroached largely on the original space*. Not only Rocque, however, but Ogilby of 1677 show a distinct enclosure or a building, falling exactly in the south-west corner of the plot, the centre of which is marked *Old Bethlem Burial Ground*. In Horwood's map of 1799, this enclosure, separated from the burial ground, still remains of much the same shape as in Rocque's. In W. Faden's map of 1813, the road between Moorfields and the Burial Ground is termed Brokers' Row—the modern Blomfield Street—and the separate enclosure in the south-west corner is called No. 1. This house stands apart from the others, and I think there is little doubt that No. 1 Brokers' Row, in 1813, stood almost on the site of the modern latrine, and since it is marked as a separate enclosure as early as 1677, was not one of the encroachments on the original burial ground to which reference has been made. Strong confirmation of this view will be found in Morden and Lea's map of 1690. In this we find that the space marked churchyard did not extend on the west fully up to Brokers' Row, or on the south to the street marked Old Bethlem. There were at that date strips of intervening land.

To account for this, I think we have only to turn back to the original condition of affairs. The hospital of St Mary Bethlem was founded by Simon Fitz-Mary in 1246 as a priory of canons with brothers and sisters. The mayor and commonalty of London, in the year 1546, purchased the patronage thereof and all the lands and tenements belonging thereto. In the same year King Henry VIII. gave the hospital to the city, and the church and chapel were removed in the reign of Elizabeth, and houses built there by the Governors of Christ's Hospital. Now if we look at Aggas' map of London in the reign of Elizabeth (from 1560), before Roe's enclosure, we see that north of St Botolph's a row of houses stretched along to the road leading north from the Moorfields postern (i.e. the later Brokers' Row) and that the road passed under an archway into some sort of a quadrangle. Within this quadrangle was a tower, like a martello tower, with a flag attached to it. This tower remains after the archway disappears, and serves to identify the quadrangle. It appears, for example, in Ryther's map of 1604, and we see that it was in the centre of the plot, which in maps of somewhat later date is marked as Old Bethlem Burial Ground. There can be little doubt accordingly, that Sir Thomas Roe fenced in a portion of the Bethlem quadrangle as the burial ground, and that this burial ground was originally separated by the buildings terminating in the archway (over Brokers' Row as it was called later) from the street afterwards termed Old Bethlem, which indeed may have partially covered the site of these houses. Thus from the very founding of the burial ground it is improbable that it ever covered the south-west corner of the plot. It would be difficult to determine when these houses disappeared, but they were gone before the middle of the 17th century, and from this time to Hollar's map of 1706 we find the western and southern boundaries of the Bethlem plot are marked as separate enclosures.

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* This is very clearly indicated in the copy of part of the "deposited" plan of the North London Railway, 1861, kindly provided by the Engineer to the Company.

The improbability that the bones are directly due to interments in Old Bethlem Burial Ground is increased by the fact that they were uncoffined. Even in excavating for Broad Street coffined bones were only found on a portion of the excavated site*. Such burials are characteristic not of ordinary interment, but of interment during an epidemic, and the want of any arrangement noted in both 1863 and 1903 tends to confirm the view that on the borders of Sir Thomas Roe's ground plague pits were dug at one or another period.

If we turn to Defoe's *Journal of the Plague Year* we find that he gives a long list of plague pits, and there is little doubt that although he was a child at the time, he was still able as a man to get recent and authentic information. After enumerating various spots where there were pits, he continues:

> "Besides this, there was a piece of ground in Moorfields, by the going into the Street which is now called Old Bethlem, which was enlarged much although not wholly taken in on the same occasion†."

This description seems to fit well the spot where the bones were found, i.e. the corner where Old Bethlem ran into Moorfields, and further accounts fully for the uncoffined mass of bones without arrangement extending from 4 to 8 or 10 ft. below the surface.

It is not of course possible to assign dogmatically a definite date and character to these Moorfields crania, but we may hold with a high degree of probability that they were drawn from the plague pit referred to by Defoe, and accordingly date from 1665.

Those who incline to believe that they originally came—as in the case of a clearance pit—from the burial ground, can assign any date from 1569 to about 1750, the ground being probably in most use not very far from the plague pit date.

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* See *Notes and Queries*, August 1, 1863.

† Morley's Edition, p. 295. The "not wholly taken in," clearly refers to the already existing Bethlem burial ground alongside.

Accepting this view would only mean somewhat greater scatter in time round about the same mean date, and we may consider ourselves fortunate, in most cases of large cranial finds, if it is possible to fix the date of the bulk of the material with anything like certainty within a hundred years.

(3) *Measurements and Methods of Measurement.*

All the detailed measurements given in my former paper are given here except G_1', the length of the palate from the base of the *spina nasalis posterior*, and the same symbols and methods of measurement were adopted as before. There were no mandibles in the collection.

Certain additional characters are given, viz.:

(j') Length from nasion to bregma (S_1).

(k') Length from bregma to lambda (S_2).

(l') Length from lambda to opisthion (S_3).

These three were measured with the steel tape.

(l'') Length from lambda to opisthion (S_3'), measured with the callipers. S_2, S_3 and S_3' were frequently difficult to measure on account of difficulty in determining the lambda precisely.

(x) Greatest length of *foramen magnum* (*fml*).

(y) Greatest breadth of *foramen magnum* (*fmb*).

(ν) Foraminal Index $\left(100\frac{fmb}{fml}\right)$.

(π) Ratio of radius of curvature of the cerebellum (from lambda to opisthion) to S_3' (CC); this measure of cerebellar curvature equals $\frac{S_3}{S_3'}\sqrt{\frac{S_3}{24(S_3-S_3')}}$ very nearly*, and will be termed the Cerebellar Index.

The Cerebellar Index, which measures the convexity towards the inion, seems useful as giving some indication of the capacity of the cerebellum. A *low* Cerebellar Index is a sign of large convexity. The Cerebellar Index of men is lower and less variable than that of women, to judge from the first investigation of it now made in this paper.

I have to thank Dr Alice Lee for help in calculating this ratio. I am also greatly indebted to Miss Winifred Gibson for the foraminal measurements and also for calculating the angles A, N, and B on the trigonometer.

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* Bertrand, *Calc. Diff.* p. 552.

TABLE I. *Cranial Means and Variability.*

Comparison of Moorfields English with Whitechapel English.

MALE.

Character and Reference Letter	Moorfields English				Whitechapel English			
	No.	Mean	Standard Deviation	Coefficient of Variation	No.	Mean	Standard Deviation	Coefficient of Variation
(*a*) C	22	1473·82 ± 19·01	132·18 ± 13·44	8·97 ± ·92	72	1476·94 ± 9·73	122·37 ± 6·88	8·28 ± ·47
(*b*) F	45	186·88 ± ·59	5·90 ± ·42	3·16 ± ·22	138	187·35 ± ·35	6·17 ± ·25	3·29 ± ·13
(*c*) L	44	189·15 ± ·57	5·58 ± ·40	2·95 ± ·21	137	189·06 ± ·36	6·27 ± ·25	3·31 ± ·13
(*d*) L'	19	188·00 ± 1·02	6·57 ± ·72	3·50 ± ·38	72	187·76 ± ·45	5·64 ± ·32	3·00 ± ·17
(*e*) B	46	143·02 ± ·53	5·31 ± ·37	3·71 ± ·26	135	140·67 ± ·31	5·28 ± ·22	3·75 ± ·15
(*f*) B'	47	98·47 ± ·41	4·12 ± ·29	4·19 ± ·29	132	98·02 ± ·25	4·20 ± ·17	4·29 ± ·17
(*g*) H	34	129·84 ± ·75	6·45 ± ·53	4·97 ± ·41	122	132·04 ± ·34	5·56 ± ·24	4·21 ± ·18
(*h*) OH ...	46	113·78 ± ·47	4·69 ± ·33	4·12 ± ·29	135	114·59 ± ·25	4·28 ± ·18	3·73 ± ·15
(*i*) LB ...	35	98·54 ± ·52	4·57 ± ·37	4·64 ± ·38	119	101·60 ± ·25	4·13 ± ·18	4·07 ± ·18
(*j*) U	37	527·08 ± 1·60	14·45 ± 1·13	2·74 ± ·21	131	524·25 ± ·88	15·02 ± ·63	2·87 ± ·12
(*k*) S	40	378·50 ± 1·28	12·01 ± ·90	3·17 ± ·24	131	377·11 ± ·81	13·69 ± ·57	3·63 ± ·15
(*l*) Q	32	305·41 ± 1·49	12·54 ± 1·06	4·11 ± ·35	115	307·93 ± ·72	11·40 ± ·51	3·70 ± ·16
(*j′*) S_1	44	129·34 ± ·56	5·55 ± ·40	4·29 ± ·31	—	—	—	—
(*k′*) S_2	43	128·72 ± ·78	7·61 ± ·55	5·91 ± ·43	—	—	—	—
(*l′*) S_3	40	120·50 ± ·90	8·48 ± ·64	7·04 ± ·53	—	—	—	—
(*l″*) S_3'	40	98·09 ± ·63	5·94 ± ·45	6·05 ± ·46	—	—	—	—
(*n*) $G'H$ ...	20	68·12 ± ·62	4·08 ± ·43	5·99 ± ·64	75	70·17 ± ·30	3·86 ± ·21	5·50 ± ·30
(*o*) GB ...	15	93·87 ± ·77	4·45 ± ·55	4·74 ± ·58	55	90·87 ± ·45	5·07 ± ·32	5·58 ± ·36
(*p*) J	7	129·00 ± 1·19	4·65 ± ·84	3·60 ± ·65	43	130·05 ± ·57	5·57 ± ·40	4·28 ± ·31
(*q*) NH ...	20	50·37 ± ·39	2·60 ± ·28	5·16 ± ·55	79	51·22 ± ·20	2·60 ± ·14	5·08 ± ·27
(*r*) NB ...	18	24·03 ± ·30	1·90 ± ·21	7·91 ± ·89	70	24·29 ± ·17	2·16 ± ·12	8·89 ± ·51
(*s*) O_1L ...	20	41·80 ± ·23	1·51 ± ·16	3·61 ± ·38	63	43·06 ± ·15	1·81 ± ·11	4·20 ± ·25
(*s′*) O_1R ...	18	42·28 ± ·22	1·42 ± ·16	3·35 ± ·38	68	42·99 ± ·16	2·02 ± ·12	4·69 ± ·27
(*t*) O_2L ...	20	32·82 ± ·32	2·12 ± ·23	6·47 ± ·69	67	33·46 ± ·15	1·88 ± ·11	5·61 ± ·33
(*t′*) O_2R ...	18	32·83 ± ·34	2·12 ± ·24	6·46 ± ·73	69	33·42 ± ·18	2·22 ± ·13	6·65 ± ·38
(*u*) G_1 ...	17	48·12 ± ·69	4·25 ± ·49	8·84 ± 1·03	69	48·27 ± ·22	2·74 ± ·16	5·68 ± ·33
(*v*) G_2 ...	15	39·73 ± ·41	2·36 ± ·29	5·94 ± ·73	66	36·78 ± ·24	2·85 ± ·17	7·75 ± ·46
(*w*) GL ...	17	95·03 ± ·67	4·12 ± ·48	4·33 ± ·50	73	95·93 ± ·35	4·49 ± ·25	4·68 ± ·26
(*x*) *fml* ...	36	35·44 ± ·32	2·86 ± ·23	8·08 ± ·65	—	—	—	—
(*y*) *fmb* ...	34	29·74 ± ·21	1·82 ± ·15	6·10 ± ·50	—	—	—	—
(*aa*) $P\angle$ ...	15	84°·50 ± ·69	3·99 ± ·49	—	63	86°·09 ± ·33	3·92 ± ·24	—
(*bb*) $A\angle$ ...	17	72°·35 ± ·61	3·71 ± ·43	—	69	73°·38 ± ·28	3·41 ± ·20	—
(*cc*) $N\angle$ ...	17	66°·56 ± ·58	3·54 ± ·41	—	69	65°·19 ± ·29	3·52 ± ·20	—
(*dd*) $B\angle$ ...	17	41°·09 ± ·44	2·71 ± ·31	—	69	41°·43 ± ·20	2·50 ± ·14	—
(*ee*) θ_1 ...	14	29°·39 ± ·53	2·94 ± ·37	—	59	28°·71 ± ·22	2·53 ± ·16	—
(*ff*) θ_2 ...	14	11°·64 ± ·43	2·41 ± ·31	—	59	12°·92 ± ·29	3·34 ± ·21	—
(α) $100\ B/L'$ ...	18	75·08 ± ·52	3·27 ± ·37	4·35 ± ·49	69	75·17 ± ·24	2·97 ± ·17	3·95 ± ·23
(β) $100\ B/L$ ...	42	75·52 ± ·31	3·00 ± ·22	3·97 ± ·29	131	74·34 ± ·19	3·26 ± ·14	4·38 ± ·18
(γ) $100\ H/L'$ ...	17	68·24 ± ·51	3·13 ± ·36	4·59 ± ·53	69	70·40 ± ·22	2·67 ± ·15	3·80 ± ·22
(δ) $100\ H/L$ ...	31	68·37 ± ·42	3·47 ± ·30	5·07 ± ·44	120	69·97 ± ·20	3·22 ± ·14	4·61 ± ·20
(ε) $100\ H/B$ ...	32	90·55 ± ·56	4·67 ± ·39	5·16 ± ·44	116	94·31 ± ·29	4·58 ± ·20	4·86 ± ·21
(θ) $100\ G'H/GB$	14	72·79 ± ·86	4·77 ± ·61	6·55 ± ·84	53	76·52 ± ·50	5·39 ± ·35	7·04 ± ·46
(κ) $100\ NB/NH$	18	47·58 ± ·66	4·13 ± ·46	8·68 ± ·98	70	47·55 ± ·37	4·58 ± ·26	9·64 ± ·55
(λ) $100\ O_2/O_1, L$	20	78·52 ± ·64	4·27 ± ·46	5·43 ± ·58	63	77·86 ± ·32	3·78 ± ·23	4·86 ± ·29
(λ′) $100\ O_2/O_1, R$	17	77·35 ± ·69	4·16 ± ·48	5·37 ± ·63	68	77·69 ± ·38	4·66 ± ·27	6·00 ± ·35
(μ) $100\ G_2/G_1$ ...	13	82·73 ± 1·05	5·59 ± ·74	6·76 ± ·90	61	76·26 ± ·55	6·40 ± ·39	8·39 ± ·52
(ν) 100 *fmb*/*fml*	34	84·20 ± ·77	6·64 ± ·54	7·89 ± ·65	—	—	—	—
(π) CC ...	40	58·52 ± ·23	2·15 ± ·16	3·68 ± ·28	—	—	—	—

TABLE I.—(*continued*). *Cranial Means and Variability.*

Comparison of Moorfields English with Whitechapel English.

FEMALE.

Character and Reference Letter	Moorfields English				Whitechapel English			
	No.	Mean	Standard Deviation	Coefficient of Variation	No.	Mean	Standard Deviation	Coefficient of Variation
(*a*) *C*	*31*	1365·31 ± 13·68	112·93 ± 9·67	8·27 ± ·71	*80*	1299·87 ± 8·51	112·80 ± 6·01	8·68 ± ·47
(*b*) *F*	*65*	182·45 ± ·52	6·24 ± ·37	3·42 ± ·20	*143*	180·14 ± ·36	6·38 ± ·25	3·54 ± ·14
(*c*) *L*	*63*	183·36 ± ·51	6·02 ± ·36	3·28 ± ·20	*140*	180·36 ± ·35	6·22 ± ·25	3·45 ± ·14
(*d*) *L′*	*23*	182·50 ± ·86	6·14 ± ·61	3·37 ± ·33	*57*	180·07 ± ·57	6·33 ± ·40	3·52 ± ·22
(*e*) *B*	*62*	137·60 ± ·45	5·28 ± ·32	3·84 ± ·23	*140*	134·68 ± ·27	4·77 ± ·19	3·54 ± ·14
(*f*) *B′*	*64*	95·16 ± ·34	4·05 ± ·24	4·25 ± ·25	*147*	93·12 ± ·23	4·23 ± ·17	4·55 ± ·18
(*g*) *H*	*47*	123·58 ± ·46	4·72 ± ·33	3·82 ± ·27	*124*	124·56 ± ·30	4·93 ± ·21	3·96 ± ·17
(*h*) *OH* ...	*59*	109·38 ± ·38	4·39 ± ·27	4·01 ± ·25	*143*	109·21 ± ·25	4·50 ± ·18	4·12 ± ·16
(*i*) *LB* ...	*46*	95·89 ± ·43	4·34 ± ·31	4·53 ± ·32	*122*	95·34 ± ·24	3·91 ± ·17	4·11 ± ·18
(*j*) *U*	*56*	512·68 ± 1·53	17·02 ± 1·08	3·32 ± ·21	*136*	503·84 ± ·85	14·70 ± ·60	2·92 ± ·12
(*k*) *S*	*53*	365·58 ± 1·26	13·56 ± ·89	3·71 ± ·24	*130*	362·76 ± ·84	14·16 ± ·59	3·90 ± ·16
(*l*) *Q*	*42*	293·07 ± 1·16	11·11 ± ·82	3·79 ± ·28	*122*	293·97 ± ·71	11·67 ± ·50	3·97 ± ·17
(*j′*) S_1	*53*	125·75 ± ·57	6·17 ± ·40	4·91 ± ·32	—	—	—	—
(*k′*) S_2	*52*	123·60 ± ·68	7·29 ± ·48	5·90 ± ·39	—	—	—	—
(*l′*) S_3	*49*	116·98 ± ·87	9·01 ± ·61	7·70 ± ·53	—	—	—	—
(*l″*) S_3'	*49*	95·91 ± ·59	6·09 ± ·41	6·35 ± ·43	—	—	—	—
(*n*) *G′H* ...	*27*	64·15 ± ·47	3·66 ± ·34	5·71 ± ·53	*62*	65·93 ± ·40	4·71 ± ·28	7·14 ± ·43
(*o*) *GB* ...	*18*	86·86 ± ·79	4·99 ± ·56	5·75 ± ·65	*58*	84·86 ± ·41	4·59 ± ·29	5·40 ± ·34
(*p*) *J*	*18*	122·00 ± ·69	4·32 ± ·49	3·54 ± ·40	*33*	120·27 ± ·58	4·97 ± ·41	4·13 ± ·34
(*q*) *NH* ...	*27*	48·02 ± ·36	2·76 ± ·25	5·74 ± ·53	*67*	48·68 ± ·22	2·70 ± ·16	5·55 ± ·32
(*r*) *NB* ...	*26*	23·40 ± ·25	1·92 ± ·18	8·21 ± ·77	*64*	23·19 ± ·14	1·64 ± ·10	7·06 ± ·42
(*s*) O_1L ...	*22*	40·93 ± ·24	1·64 ± ·17	4·02 ± ·41	*57*	41·17 ± ·13	1·45 ± ·09	3·53 ± ·22
(*s′*) O_1R ...	*25*	40·90 ± ·23	1·67 ± ·16	4·09 ± ·39	*62*	40·95 ± ·14	1·64 ± ·10	4·00 ± ·24
(*t*) O_2L ...	*22*	32·84 ± ·34	2·34 ± ·24	7·11 ± ·73	*64*	33·59 ± ·12	1·45 ± ·09	4·31 ± ·26
(*t′*) O_2R ...	*25*	32·60 ± ·27	2·03 ± ·19	6·22 ± ·60	*64*	33·73 ± ·13	1·51 ± ·09	4·47 ± ·27
(*u*) G_1 ...	*20*	45·92 ± ·43	2·83 ± ·30	6·15 ± ·66	*57*	45·13 ± ·26	2·95 ± ·19	6·53 ± ·41
(*v*) G_2 ...	*22*	37·04 ± ·40	2·80 ± ·28	7·55 ± ·77	*58*	35·22 ± ·24	2·70 ± ·17	7·68 ± ·48
(*w*) *GL* ...	*25*	92·14 ± ·76	5·66 ± ·54	6·14 ± ·59	*58*	90·42 ± ·40	4·47 ± ·28	4·95 ± ·31
(*x*) *fml* ...	*50*	34·29 ± ·24	2·49 ± ·17	7·26 ± ·49	—	—	—	—
(*y*) *fmb* ...	*50*	29·01 ± ·23	2·43 ± ·16	8·39 ± ·57	—	—	—	—
(*aa*) *P*∠ ...	*19*	84°·76 ± ·35	2·26 ± ·25	—	*52*	87°·13 ± ·27	2·85 ± ·19	—
(*bb*) *A*∠ ...	*26*	73°·33 ± ·30	2·29 ± ·21	—	*57*	73°·90 ± ·29	3·31 ± ·21	—
(*cc*) *N*∠ ...	*26*	66°·65 ± ·37	2·82 ± ·26	—	*57*	64°·70 ± ·23	2·53 ± ·16	—
(*dd*) *B*∠ ...	*26*	40°·02 ± ·35	2·67 ± ·25	—	*57*	41°·39 ± ·27	2·98 ± ·19	—
(*ee*) θ_1 ...	*19*	28°·50 ± ·33	2·15 ± ·24	—	*50*	28°·11 ± ·24	2·51 ± ·17	—
(*ff*) θ_2 ...	*19*	11°·47 ± ·37	2·36 ± ·26	—	*50*	13°·13 ± ·34	3·60 ± ·24	—
(α) 100 B/L' ...	*21*	75·38 ± ·30	2·02 ± ·21	2·68 ± ·28	*55*	74·62 ± ·27	3·01 ± ·19	4·03 ± ·26
(β) 100 B/L ...	*57*	75·05 ± ·21	2·36 ± ·15	3·14 ± ·20	*130*	74·73 ± ·18	2·98 ± ·12	3·99 ± ·17
(γ) 100 H/L' ...	*20*	67·07 ± ·41	2·75 ± ·29	4·10 ± ·44	*55*	69·05 ± ·26	2·91 ± ·19	4·21 ± ·27
(δ) 100 H/L ...	*44*	67·17 ± ·28	2·78 ± ·20	4·14 ± ·30	*117*	69·13 ± ·18	2·83 ± ·12	4·10 ± ·18
(ε) 100 H/B ...	*44*	89·93 ± ·40	3·96 ± ·28	4·40 ± ·32	*115*	92·35 ± ·24	3·84 ± ·17	4·16 ± ·18
(θ) 100 $G'H/GB$	*18*	73·55 ± ·64	4·01 ± ·45	5·46 ± ·61	*54*	77·94 ± ·57	6·26 ± ·41	8·04 ± ·52
(κ) 100 NB/NH	*26*	48·73 ± ·52	3·96 ± ·37	8·12 ± ·76	*64*	47·79 ± ·33	3·90 ± ·23	8·16 ± ·49
(λ) 100 O_2/O_1, *L*	*22*	80·34 ± ·84	5·83 ± ·59	7·26 ± ·74	*57*	81·70 ± ·38	4·23 ± ·27	5·18 ± ·33
(λ′) 100 O_2/O_1, *R*	*25*	79·76 ± ·75	5·53 ± ·53	6·93 ± ·66	*62*	82·46 ± ·37	4·33 ± ·26	5·25 ± ·32
(μ) 100 G_2/G_1...	*19*	81·24 ± ·71	4·62 ± ·50	5·69 ± ·62	*51*	77·69 ± ·62	6·62 ± ·44	8·52 ± ·57
(ν) 100 *fmb*/*fml*	*47*	84·45 ± ·60	6·12 ± ·43	7·25 ± ·51	—	—	—	—
(π) *CC* ...	*49*	59·24 ± ·28	2·90 ± ·20	4·90 ± ·33	—	—	—	—

(4) *Capacity.*

Circumstances prevented me from measuring the capacity of the skulls, and this laborious piece of work was most kindly carried out by Miss M. Radford and Professor Karl Pearson, by the method of weighing and comparing with Professor Thane's standard skulls which I had previously adopted.

After many preliminary trials, they decided to use as their standard the "crâne étalon," which I called "α"*, and finally determined the constant for reducing to volume the weight of mustard seed contained in the skulls as $\frac{1000}{766\cdot55}$, which agrees fairly closely with my determination $\frac{1000}{768\cdot33}$.

(5) *Mean Value and Variability.*

Table I. gives the means, standard deviations and coefficients of variation, with their probable errors, of the characters, and will enable us to see to what extent the Moorfields and Whitechapel series agree with each other. If it can be established that they agree very closely, it will be unnecessary to institute an elaborate comparison between our present series and other races, such as I made in the case of the Whitechapel skulls, as the same conclusions will apply to both. I will therefore confine myself to a somewhat detailed comparison of our two London series.

TABLE II.

Capacity and Lengths. Means.

Character	MALE		FEMALE	
	Moorfields	Whitechapel	Moorfields	Whitechapel
C	1474	1477	1365	1300
L	189·1	189·1	183·4	180·4
B	143·0	140·7	137·6	134·7
B'	98·5	98·0	95·2	93·1
H	129·8	132·0	123·6	124·6
OH	113·8	114·6	109·4	109·2
LB	98·5	101·6	95·9	95·3

In males the chief difference is in *LB* (length of skull base from nasion to basion); also in height and maximum breadth the series differ, the Moorfields being broader but less high; the other characters are closely alike.

The Moorfields female skull is markedly more capacious, being longer, broader, and higher.

I consider in the second place the circumferences.

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* *Biometrika*, Vol. III. p. 204.

TABLE III.

Circumferences. Means.

Character	MALE		FEMALE	
	Moorfields	Whitechapel	Moorfields	Whitechapel
U	527·1	524·2	512·7	503·8
S	378·5	377·1	365·6	362·8
Q	305·4	307·9	293·1	294·0

The male skulls are strikingly alike, while in the female skulls the larger U was to be expected in the Moorfields group, owing to their greater length and breadth.

We next come to characters of which the frequencies in the Moorfields series are very few, and the comparison is thus less satisfactory.

TABLE IV.

Face Measurements. Means.

Character	MALE		FEMALE	
	Moorfields	Whitechapel	Moorfields	Whitechapel
$G'H$	68·1	70·2	64·1	65·9
GB	93·9	90·9	86·9	84·9
J	129·0	130·0	122·0	120·3
NH	50·4	51·2	48·0	48·7
NB	24·0	24·3	23·4	23·2
O_1L	41·8	43·1	40·9	41·2
O_1R	42·3	43·0	40·9	40·9
O_2L	32·8	33·5	32·8	33·6
O_2R	32·8	33·4	32·6	33·7

The only important differences are in $G'H$ and GH (upper face height and face breadth) the former of which is shorter, the latter broader in the Moorfields skulls, both male and female.

As regards the palate, the two series agree in length, but differ considerably in breadth, in males and females, but breadth of palate I have again found a somewhat unsatisfactory character to measure*.

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* *Biometrika*, Vol. III. p. 202.

The two series, in both sexes, agree closely in the angles A, N, and B of the triangle whose apices are the nasion, basion, and alveolar point*. The profile angle, P, is the larger in Whitechapel females.

TABLE V.

Chief Indices. Means.

Character	Male		Female	
	Moorfields	Whitechapel	Moorfields	Whitechapel
100 B/L	75·5	74·3	75·0	74·7
100 H/L	68·4	70·0	67·2	69·1
100 H/B	90·5	94·3	89·9	92·3
$G'H/GB$	72·8	76·5	73·5	77·9
NB/NH	47·6	47·5	48·7	47·8
O_2/O_1, L	78·5	77·9	80·3	81·7
O_2/O_1, R	77·3	77·7	79·8	82·5
G_2/G_1	82·7	76·3	81·2	77·7

Here, as we should expect, there are differences between the two series where B, H, $G'H$, GB, and G_2 are involved.

In order to compare the variability of the two collections, I will now give side by side the standard deviations of the chief characters.

TABLE VI.

Capacity and Lengths. Coefficients of Variation.

Character	Male		Female	
	Moorfields	Whitechapel	Moorfields	Whitechapel
C	8·97	8·28	8·27	8·68
L	2·95	3·31	3·28	3·45
B	3·71	3·75	3·84	3·54
B'	4·19	4·29	4·25	4·55
H	4·97	4·21	3·82	3·96
OH	4·12	3·73	4·01	4·12
LB	4·64	4·07	4·53	4·11

The general agreement is close between the two series.

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* *Biometrika*, Vol. III. pp. 211 and 213.

TABLE VII.

Circumferences. Coefficients of Variation.

Character	MALE		FEMALE	
	Moorfields	Whitechapel	Moorfields	Whitechapel
U	2·74	2·87	3·32	2·92
S	3·17	3·63	3·71	3·90
Q	4·11	3·70	3·79	3·97

Here again the two series agree very well.

The frequencies of the remaining characters are too few in the Moorfields group to enable us to make a satisfactory comparison; I give, however, in the following Table the figures for face measurements.

TABLE VIII.

Face Measurements. Coefficients of Variation.

Character	MALE		FEMALE	
	Moorfields	Whitechapel	Moorfields	Whitechapel
$G'H$	5·99	5·50	5·71	7·14
GB	4·74	5·58	5·75	5·40
J	3·60	4·28	3·54	4·13
NH	5·16	5·08	5·74	5·55
NB	7·91	8·89	8·21	7·06
O_1L	3·61	4·20	4·02	3·53
O_1R	3·35	4·69	4·09	4·00
O_2L	6·47	5·61	7·11	4·31
O_2R	6·46	6·65	6·22	4·47

The most important difference is in $G'H$ (upper face height) and in the breadth of orbit, in females, but the smallness of the Moorfields frequencies has to be kept in mind.

The coefficients of variation in palate measurements are markedly different in the two series in males, but in females they are about the same.

The following Table gives the coefficients of variation of those indices, for which the frequencies are over 30 in the Moorfields series.

TABLE IX.

Indices. Coefficients of Variation.

Characters	Male		Female	
	Moorfields	Whitechapel	Moorfields	Whitechapel
$100\,B/L$	3·97	4·38	3·14	3·99
$100\,H/L$	5·07	4·61	4·14	4·10
$100\,H/B$	5·16	4·86	4·40	4·16

The agreement is seen to be fairly close.

An examination of these Tables will, I think, establish the conclusion that the Moorfields and Whitechapel skulls are strikingly similar both as regards means and variability, and that the peculiar features on which I dwelt when discussing the Whitechapel crania are present in the Moorfields also. Moorfields females show even greater average length than Whitechapel, and in spite of their greater breadth the cephalic index, 75, is much less than that assumed for modern English[*]. The above conclusion is confirmed by an examination of the abnormalities of the present series, which will be given later on.

I add a specification of the Moorfields crania, for purposes of comparison.

TABLE X. *Specification of Moorfields Crania.*

Character	Class		Remarks
	♂	♀	
$100B/L$	Mesocephaly	Mesocephaly	Close on border of dolichocephaly, sexes practically alike
$100H/L$	Chamaecephaly	Chamaecephaly	Sexes nearly alike; well within borders of chamaecephaly
Profile Angle	Mesognathy	Mesognathy	Sexes alike, tending towards prognathy
Upper Face Index...	Narrow faced	Narrow faced	Sexes nearly alike
Zygomatic Upper Face Index†	Leptoprosopy	Leptoprosopy	♂ 52·8, ♀ 52·6
Orbital Index	Chamaeconchy	Chamaeconchy	In both eyes practically the same in each sex, but female rounder
Nasal Index	Mesorrhiny	Mesorrhiny	Male near leptorrhiny
Palate Index	Mesostaphyline	Mesostaphyline	Female tends to leptostaphyline
Alveolar Index†	96·44	96·10	Sexes alike

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[*] *Biometrika*, Vol. III. p. 209.

† These indices are the ratios of the means of the characters; the former is $100\,G'H/J$, the latter $100\,GL/LB$.

(6) *Photographic Study of the Moorfields Skulls*[*].

A photographic study of the Moorfields crania brings out even more markedly than the numerical measurements the wide divergence of the English skull of the Londoner of two centuries ago, and possibly of his successor of to-day, from the types of our nearest continental neighbours. A magnificent cranium like that on Plate XVII. is exceptional, although it also shows the very prevalent bathrocephaly; crania like those on Plates XIII. to XVI. are far more frequent, and one recognises at once features of a somewhat primitive or debased type. It seems urgently necessary that a large series of crania from another part of the kingdom, and if possible from a rural district, and of about the same period, should be examined. Is it possible that the contents of plague pits in a city like London only provide us with a debased sample of the population? Or again, is the Londoner of to-day really different from this man of two centuries ago? If he be, is the change the result of selection, immigration, or altered environment? One must confess to a certain feeling of unrest, so long as the two largest series of English skulls, of which we have complete measurements, namely the Whitechapel and Moorfields series, give the English these not very flattering cranial characters.

The remainder of our photographs have been selected to preserve records of special abnormalities for future comparison and reference. Plate IX. gives a fine example of an ossicle of the bregma; Plate VI. completes our English series of tripartite interparietals, the *ossa triangularia* being detached and the *os pentagonale* fused; compare *Biometrika,* Vol. III. p. 220 and Plates XXXVI.—XXXIX.; Plates VII. and VIII. illustrate double and triple ossicles of the lambda and should be compared with Plate XXXIV. of the Whitechapel memoir; Plate X. provides a striking instance of supernumerary condyle with articulating facet; Plate XII. shows the post-coronal depression frequently referred to, and is besides an illustration of the very common receding forehead; and Plate XI. reproduces a remarkably symmetrical pear-shaped *norma verticalis.* Such pear-shaped domes—often curiously regular and smooth in texture—will be familiar to all craniologists as occurring in a small percentage of cases in most cranial series. An index to this characteristic might possibly be taken as follows: The skull being adjusted to the horizontal plane on the craniophor, mark on the sagittal circumference the points in which the vertical planes through the greatest breadth (B) and through the minimum forehead breadth (B') meet this circumference; let the horizontal distance between these points be D[†]. Then $100\,(B-B')/D$ is the suggested index. It might perhaps be termed the Pyroid Index. I suggest that the Pyroid Index will be found to be of some racial and sexual value, and I hope that a study of it at least in English crania will soon be published.

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[*] I have to thank Professor Karl Pearson very cordially for the great trouble he has taken in photographing the skulls.

[†] Easily measured with the spanner described in *Biometrika,* Vol. I. p. 415.

(7) *Special Crania*[*].

In the 120 skulls which form the subject of this paper, 264 anatomical peculiarities were noted, on an average 2·2 for each skull, as against an average of ·96 for each skull in the Whitechapel series[†]. Of the total 120 skulls, 50 were adjudged male, with 107 peculiarities; the average number of peculiarities to each male skull was therefore 2·14, while in the Whitechapel series it was ·91; the number considered to be female being 70, with 157 peculiarities, the average number to each female skull was 2·24, compared with 1·0 in the Whitechapel collection. In both series it will be observed that the female skull has a somewhat greater tendency to abnormal variation than the male.

This high frequency of abnormal characters, although some of them, it is true, are very slight, tends to confirm the general conclusion arrived at from an examination of the Whitechapel series, that the English skull is probably remarkable for abnormal variations[‡]. The increase of the percentage in the case of the Moorfields crania is to some extent, but I think not wholly, due to still closer examination.

I shall now draw attention to some of the individual cases of abnormality, adopting the classification used in the Whitechapel paper.

(i) *Peculiarities of Form.*

Post-coronal constriction occurred in only 2 skulls, 1 male and 1 female. When localised about the bregma, we have noted this peculiarity as *post-coronal depression,* and it occurred in 33 skulls, 17 male and 16 female: in 11 of the 17 males and in 9 of the 16 females, it was noted as slight or faint. The cases of constriction are remarkably few when compared with those of the Whitechapel collection, where 19 cases occurred (mostly in female crania) in a total of 292 crania; but taking constriction and depression together we observe that the cases are relatively about twice as frequent in the present series, the figures being 35 in 120, as compared with 46 in 292.

Two female skulls showed *post-coronal flattening,* and 2 others *pre-coronal depression.*

Two female skulls present a *metopic ridge,* associated in one case with a metopic suture (see below).

Flattening of the obelion was noticed in 7 skulls, 2 male and 5 female, *and depression of the obelion* also in 7 cases, 2 male and 5 female. In 4 crania (all female) the *obelion is grooved,* while 7 others (3 male and 4 female) show *posterior sagittal grooving,* and 1 male presents a slight *mid-sagittal groove.* A *coronal ridge* was found in 1 male skull, and a *sagittal ridge in* 3 skulls (2 male and 1 female). *Post-parietal flattening* is recorded in 3 skulls (2 male and 1 female); 1 female skull is noted as showing *parietal bulging*; and another shows *parietal expansion* with slight right *parieto-occipital flattening.*

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[*] I have again to thank Professor Thane for his unfailing readiness with help and correction.

[†] *Biometrika,* Vol. III. p. 217.

[‡] *Biometrika,* Vol. I. p. 217.

Skulls with *protuberant occiput* have been specially noted in this series; of these 5 males are recorded as having the occiput prominent or protuberant, and 7 males as presenting the same condition in a slight degree. For females, the corresponding figures are 11 with prominent, and 8 with slightly prominent occiput. *Bathrocephaly* occurs in 13 skulls, 5 male (of which 4 are slightly and 1 markedly bathrocephalic), and 8 females (of which 6 are slightly and 2 markedly bathrocephalic). This shows a percentage twice that of the Whitechapel series. In 2 of the male and 10 of the female cases of bathrocephaly it is noted that there are no ossicles in the lambdoid suture, while in two other female cases the lambdoid suture is obliterated.

Two cases of *receding forehead* are noted in male skulls, one of which has the calvaria depressed, while the other is recorded as doubtfully *microcephalic.* One female is recorded as having an *infantile upper face.* Only 1 male and 1 female skull are noted as *plagiocephalic*; and 1 female skull is rather *pear-shaped* in the norma verticalis (see Plate XI.). In 1 female skull left *occipital flattening* occurs; and in another marked *occipital asymmetry.*

A *marked inion* is noted in 5 skulls, 4 male and 1 female. A *torus occipitalis* occurs, with varying degrees of prominence, in 28 skulls, 15 male and 13 female; the proportion is much higher than in the Whitechapel skulls, in which this peculiarity was met with in only 13 out of 292.

A *linguiform process of the occipital bone* is noted in 5 skulls, all female.

In only 2 female skulls were two *precondylar eminences* noticed, one pair small, the other minute. In this respect the collection is in marked contrast to the Whitechapel series, in which 14 skulls with these eminences were recorded.

In 1 female skull a *facet* is noted on the *anterior margin of the foramen magnum,* on another a small *articular facet on the left jugular process,* and in a third a right *paroccipital process* for articulation with the atlas. (See Plate X.)

The following peculiarities are also recorded: 1 case (female) of a *median parietal foramen*; 1 (female) of *foramen jugulare spurium*; 1 of bilateral *pterygo-spinous bridge,* also female; 2 cases of a *horizontal foramen in the spinous sphenoid,* 1 (male) on the left side, the other (female) on both sides; and four instances of *porus crotaphitico-buccinatorius* (1 male and 3 female), as compared with only two in the Whitechapel skulls.

(ii) *Anomalies of the Sutures.*

Eight skulls are metopic, 5 male and 3 female (in one of the females there is also a metopic ridge, see above). Although the instances are few, it may be of interest to make up a Table as was done for the Whitechapel skulls, showing how the mean maximum head breadth and minimum forehead breadth of these 8 metopic skulls compare with the means for the whole series.

TABLE XI.

Comparison of Metopic and General Skulls.

Character	Male Skull		Female Skull	
	General	Metopic	General	Metopic
Maximum Head Breadth ...	143·0	144·2	137·6	138·6
Minimum Forehead Breadth	98·5	103·7	95·2	101·0

These figures, so far as they go, show that the conclusion drawn from the Whitechapel measurements was well within the mark*, viz., that a persistent frontal suture may allow of a 2 to 3 mm. increase in the minimum forehead breadth, but probably influences the maximum head breadth only very slightly.

Traces of a *transverse occipital suture* passing between the upper and lower inial eminences occurred in one female skull; also vestiges of this suture, on both sides, in one male skull. A distinct *masto-squamosal suture* was noticed in a female skull, and in another female an *infraorbital suture* on the face.

A *fronto-squamosal articulation*, by means of a more or less developed frontal process of the squamous temporal, was met with in 6 skulls, 2 male (bilateral) and 4 female (2 bilateral, 1 right, 1 left).

(iii) *Interparietals.*

On close examination it has turned out that interparietals are very rare in this series. In addition to the two instances of vestigial transverse occipital suture mentioned above, there is only one case of a *tripartite interparietal*, in which the *os pentagonale* is fused with the supraoccipital, while the *ossa triangularia*, right and left, are distinct. (See Plate VI.)

(iv) *Ossicles and Wormian Bones.*

Ossicles of the bregma were noted in 3 cases (2 male and 1 female); *of the lambda* in 8 (4 male and 4 female); *of the asterion* in 2 female skulls, and *of the pterion* in 9 cases (3 male and 6 female). There were 4 cases, all female, of ossicles, usually triangular, in the *parietal notch* of right and left *temporal.*

Ossicles or Wormian bones were recorded in *sutures* as follows: 21 cases in the *lambdoid* (11 male and 10 female); 2 in the *parieto-mastoid*, both female; and 1, a female, in the *occipito-mastoid*. In all, 36 skulls (17 male and 19 female), or 30 per cent., had anomalous ossicles in one or more of the regions indicated.

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* *Biometrika*, Vol. III. p. 220.

(v) *Teeth.*

Teeth were present in only a few skulls, but in these the following peculiarities were noted, all in female skulls: in one case the left canine has descended behind the lateral incisor (as in the Whitechapel skull No. 7041); in another, the premolar and molar ranges were markedly convex downwards; and in a third, there was a retained and displaced canine.

The result of this examination, I venture to think, is that, in spite of the paucity of examples of precondylar eminences and interparietals, which were so remarkable a feature in the Whitechapel skulls, our present series has a peculiar interest of its own, owing to the great number of abnormalities of one kind or another which it displays.

(8) *Frequency Distributions and Correlation of Cranial Characters.*

Owing to the shortness of the Moorfields series I have not calculated the frequency distributions, and for the same reason a determination of the numerous correlations which were given in my Whitechapel paper is not attempted here; but it may be of some interest to show the correlations of head length, breadth, and height in female skulls, as there are considerably more of them than of males. These are shown in the following Table:

TABLE XII.

Correlation of Cranial Characters. Female Crania.

Pair of Characters	No.	Moorfields English	No.	Whitechapel English
L and *H*	*44*	·239 ± ·096	*120*	·425 ± ·051
L and *B*	*57*	·619 ± ·055	*130*	·350 ± ·052
B and *H*	*44*	·293 ± ·093	*115*	·340 ± ·056

The differences are somewhat considerable, although in the first and last case within the range indicated by once to twice the probable error. The high correlation between *L* and *B* in the case of the Moorfields crania is remarkable, and exceeds considerably the values hitherto obtained. If not due to some special disturbing source in the sample, e.g. the preservation of some very small female skulls, it shows how little weight can be laid on the correlation values obtained from small series of crania.

(9) *General Conclusions.*

The general conclusions to which I was led by a detailed study of the Whitechapel skulls and a partial examination of the Moorfields series were given in my former paper*, and are confirmed by the fuller investigation contained in the present memoir. Fortunately we are now in possession of much more information regarding the Long Barrow Skulls than when I first wrote: I refer to Mr E. H. J. Schuster's paper on the Long Barrow and Round Barrow skulls in the Oxford Museum*. With the aid of his results I am able to construct the following Comparative Table, which is an enlargement of Table XIX of my Whitechapel memoir†.

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* *Biometrika*, Vol. III. pp. 206—7, 217, 240—244.

TABLE XIII.

Comparison of Moorfields and Whitechapel with Long Barrow Skulls.

Character	Male						Female					
	Moorfields		Whitechapel		Long Barrow		Moorfields		Whitechapel		Long Barrow	
	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean
L'	19	188·0	72	187·8	8	191·9	23	182·5	57	180·1	3	185·3
L	44	189·1	137	189·0	16	190·6	63	183·4	140	180·4	13	182·6
F	45	186·9	138	187·3	17	187·1	65	182·4	143	180·1	12	184·0
B	46	143·0	135	140·7	18	142·4	62	137·6	140	134·7	12	138·6
B'	47	98·5	132	98·0	16	98·9	64	95·2	147	93·1	11	94·1
H	34	129·8	122	132·0	12	137·8	47	123·6	124	124·6	9	135·1
OH	46	113·8	135	114·6	9	120·7	59	109·4	143	109·2	3	118·0
LB	35	98·5	119	101·6	11	101·9	46	95·9	122	95·3	8	96·8
fml	36	35·4	—	—	11	35·7	50	34·3	—	—	6	34·5
fmb	34	29·7	—	—	11	27·7	50	29·0	—	—	6	30·2
U	37	527·1	131	524·2	16	534·9	56	512·7	136	503·8	7	518·7
S	40	378·5	131	377·1	13	384·8	53	365·6	130	362·8	8	382·0
Q	32	305·4	115	307·9	9	321·8	42	293·1	122	294·0	3	312·0
$G'H$	20	68·1	75	70·2	13	69·9	27	64·1	62	65·9	4	66·7
GB	15	93·9	55	90·9	12	95·9	18	86·9	58	84·9	4	92·7
J	7	129·0	43	130·0	3	134·0	18	122·0	33	120·3	1	132·5
NH	20	50·4	79	51·2	15	49·4	27	48·0	67	48·7	7	47·0
NB	18	24·0	70	24·3	15	24·1	26	23·4	64	23·2	7	22·8
GL	17	95·0	73	95·9	9	95·3	25	92·1	58	90·4	4	92·6
$100\,B/L'$	18	75·1	69	75·2	8	74·4	21	75·4	55	74·6	3	74·3
$100\,B/L$	42	75·5	131	74·3	16	74·9	57	75·0	130	74·7	12	76·3
$100\,H/L$	31	68·4	120	70·0	11	72·7	44	67·2	117	69·1	8	74·0
$100\,G'H/GB$	14	72·8	53	76·5	9	71·4	18	73·5	54	77·9	1	81·0
$100\,NB/NH$	18	47·6	70	47·5	15	49·0	26	48·7	64	47·8	6	49·1
P	15	84·5°	63	86·1°	5	83·0°	19	84·8°	52	87·1°	—	—

An examination of this Table and of the other comparative tables given in this and the former paper amply justifies me, I think, in re-affirming my main propositions, viz. that the Whitechapel and Moorfields skulls with which we have been dealing represent the typical London skull of two centuries ago, and that notwithstanding some differences, especially in height measurements, the type can be described as approaching that of the Long Barrow men.

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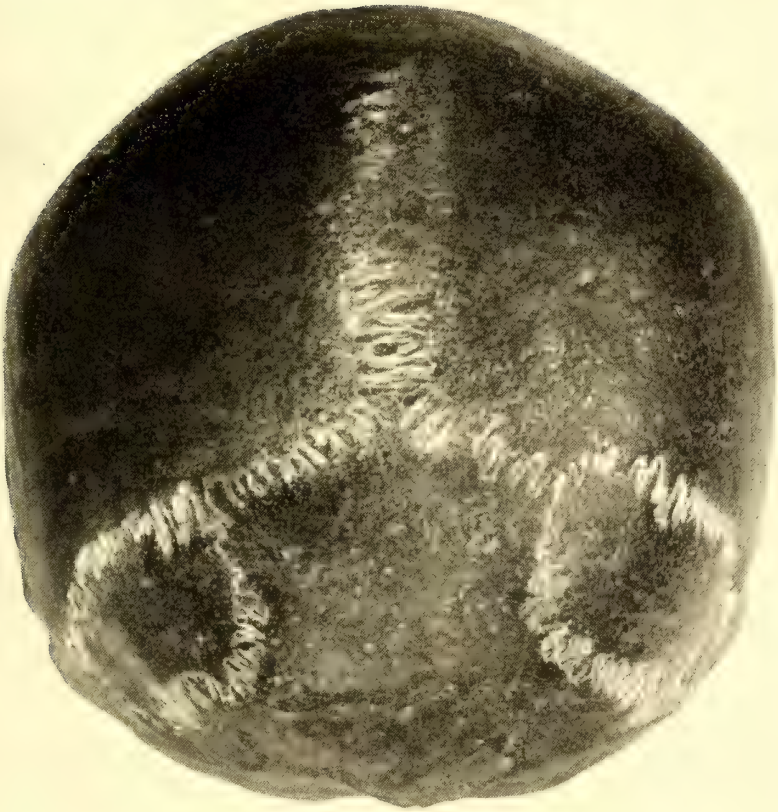
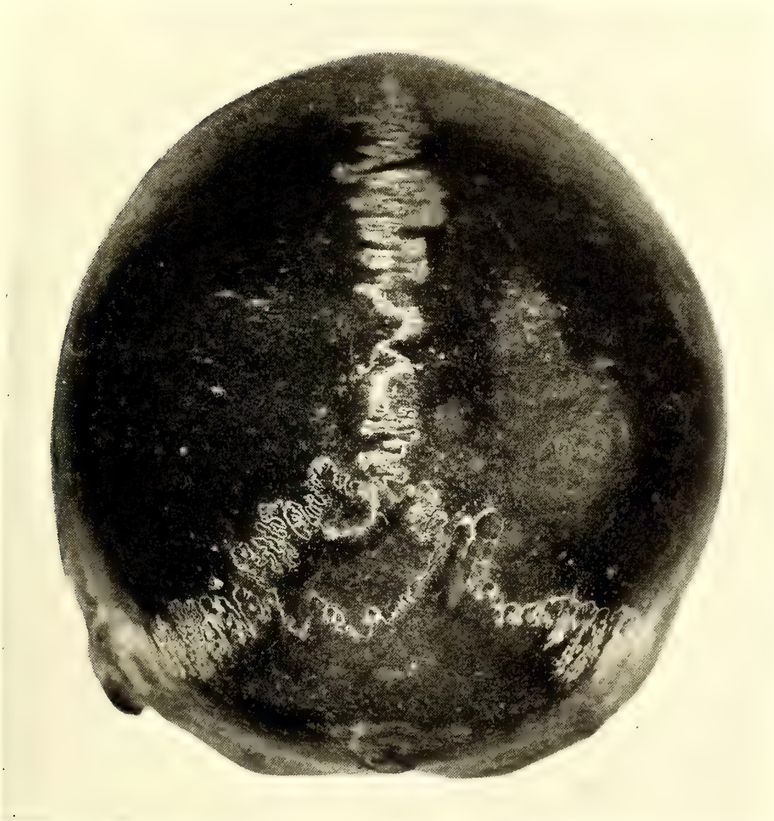
* *Biometrika*, Vol. IV. pp. 351—362.

† I do not include eye and palate, as Mr Schuster and I have not adopted the same method of measurement; probably also in measuring Q our methods would lead to somewhat different results.



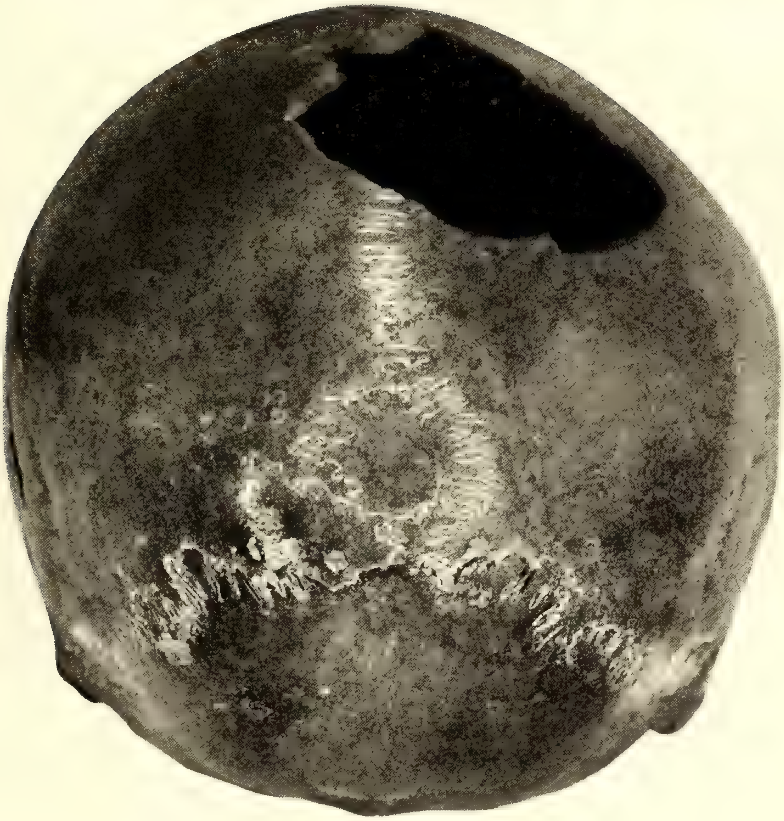
Moorfields Crania. Special Skull. Tripartite Interparietal with os pentagonale fused. Ossa triangularia free.

L. S. 2.



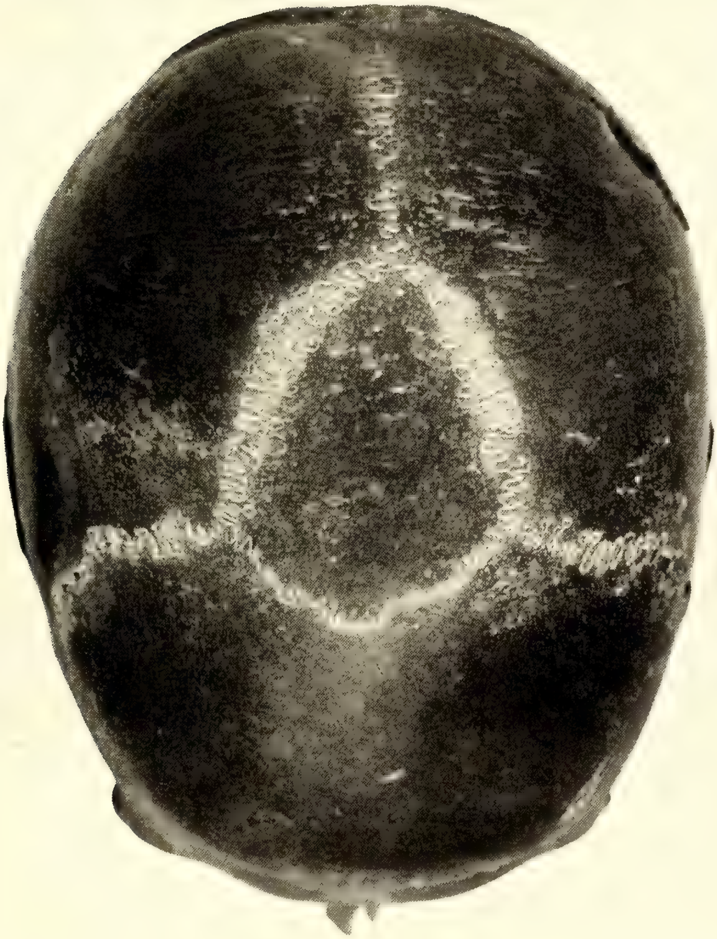
Moorfields Crania. Special Skull. Double Ossicle of Lambda.

L. S. 36.



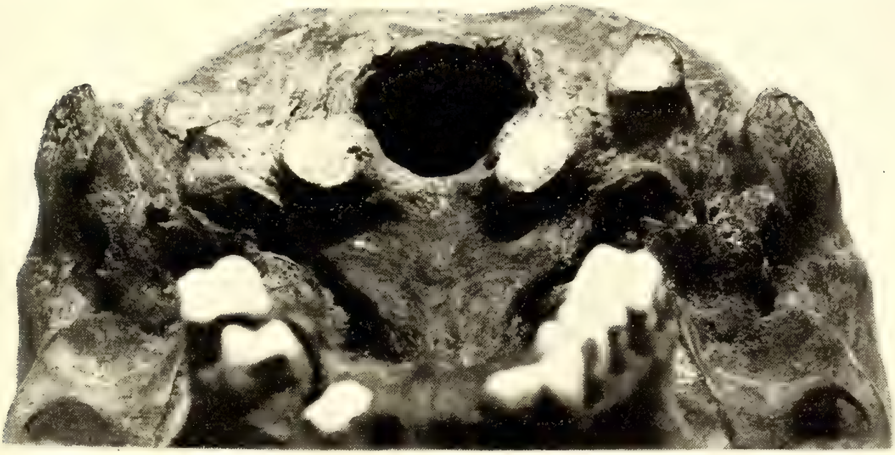
Moorfields Crania. Special Skull. Triple Ossicle of Lambda.

L. S. 56.



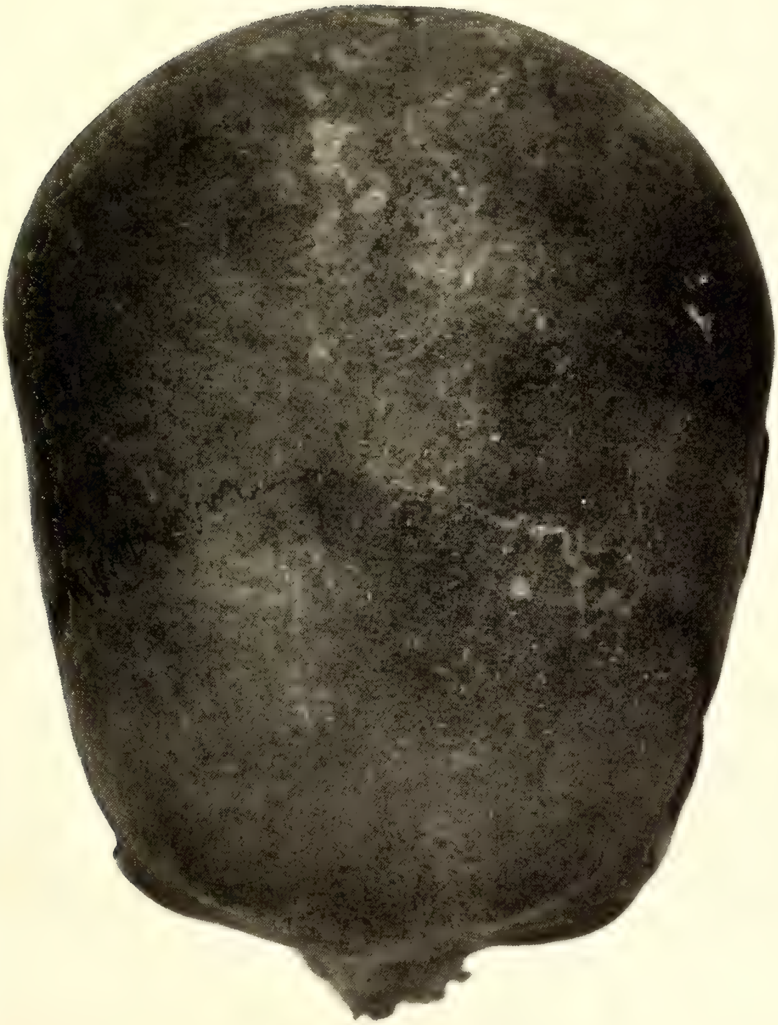
Moorfields Crania. Special Skull. Ossicle of Bregma.

L. S. 66.



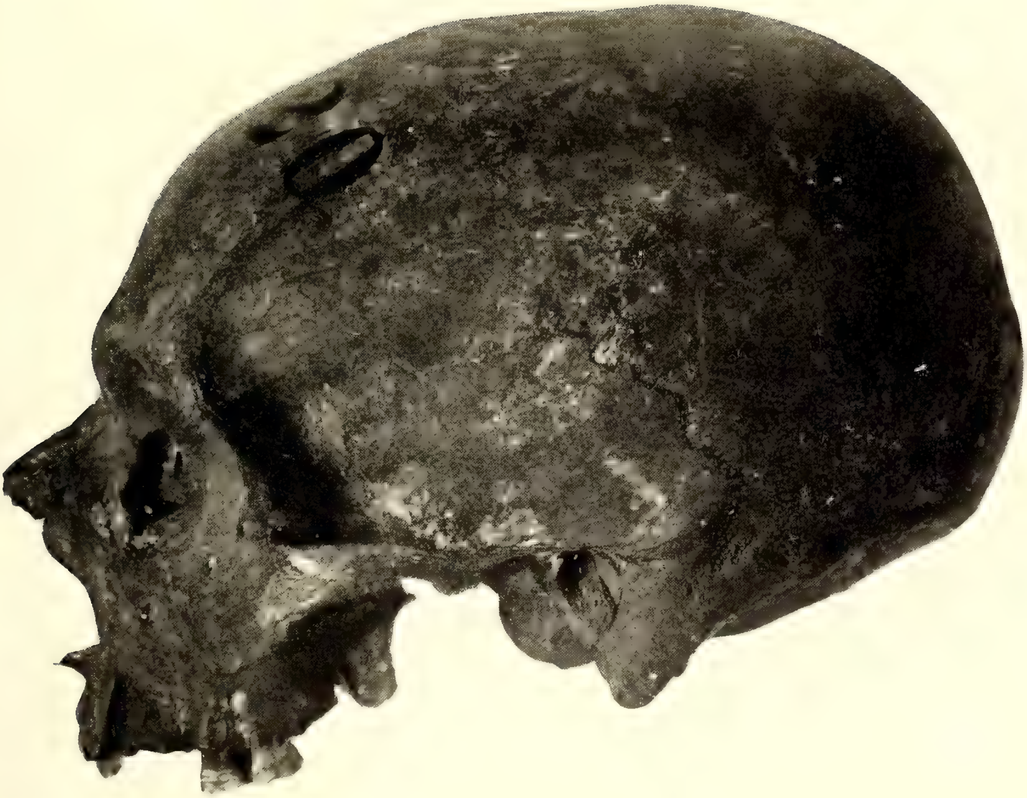
Moorfields Crania. Special Skull. Paroccipital Process articulating with Atlas.

L. S. 36.



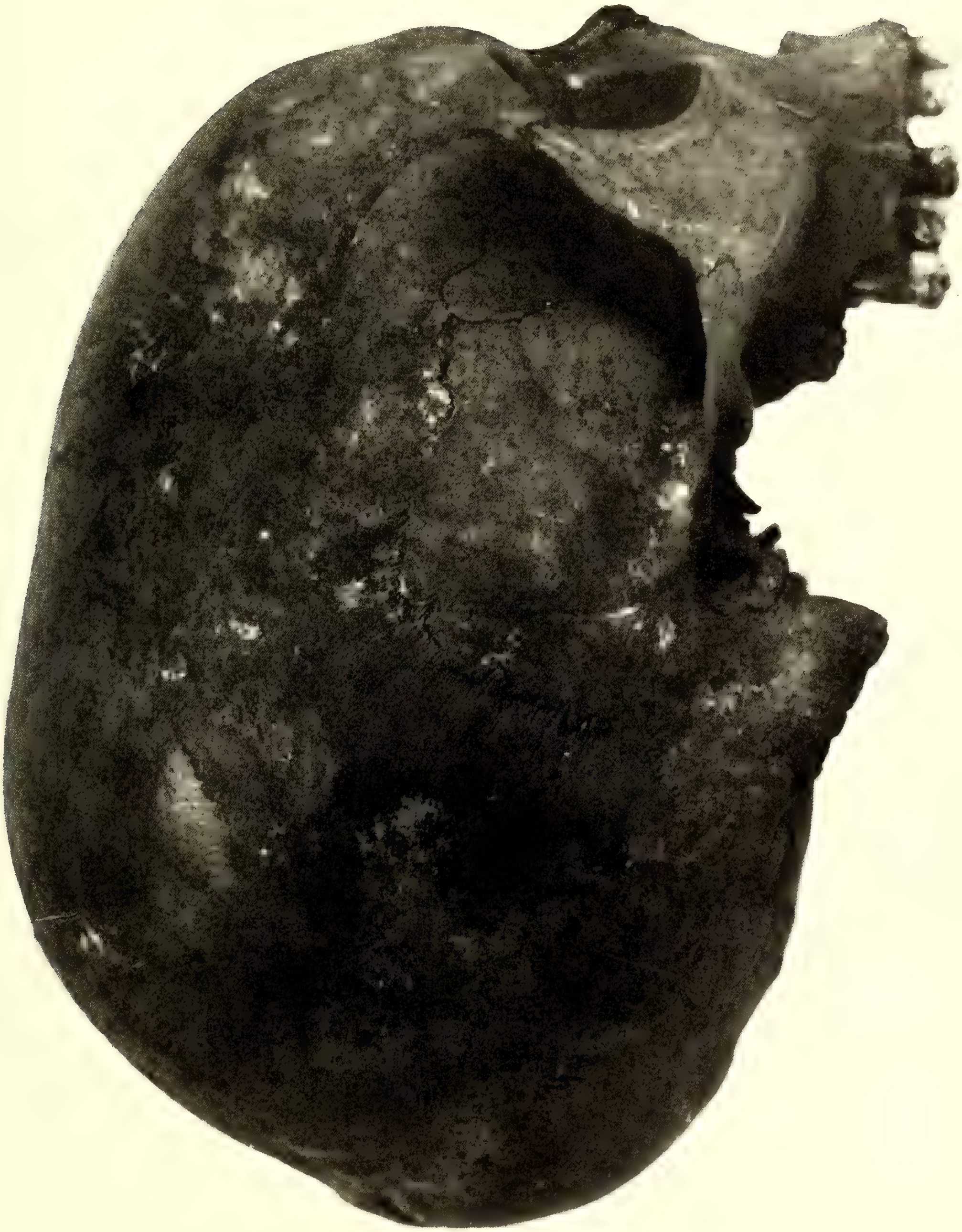
Moorfields Crania. Special Skull. Pear-shaped in *Norma Verticalis.*

L. S. 97.



Moorfields Crania. Special Skull. Showing receding Forehead and post-coronal Depression.

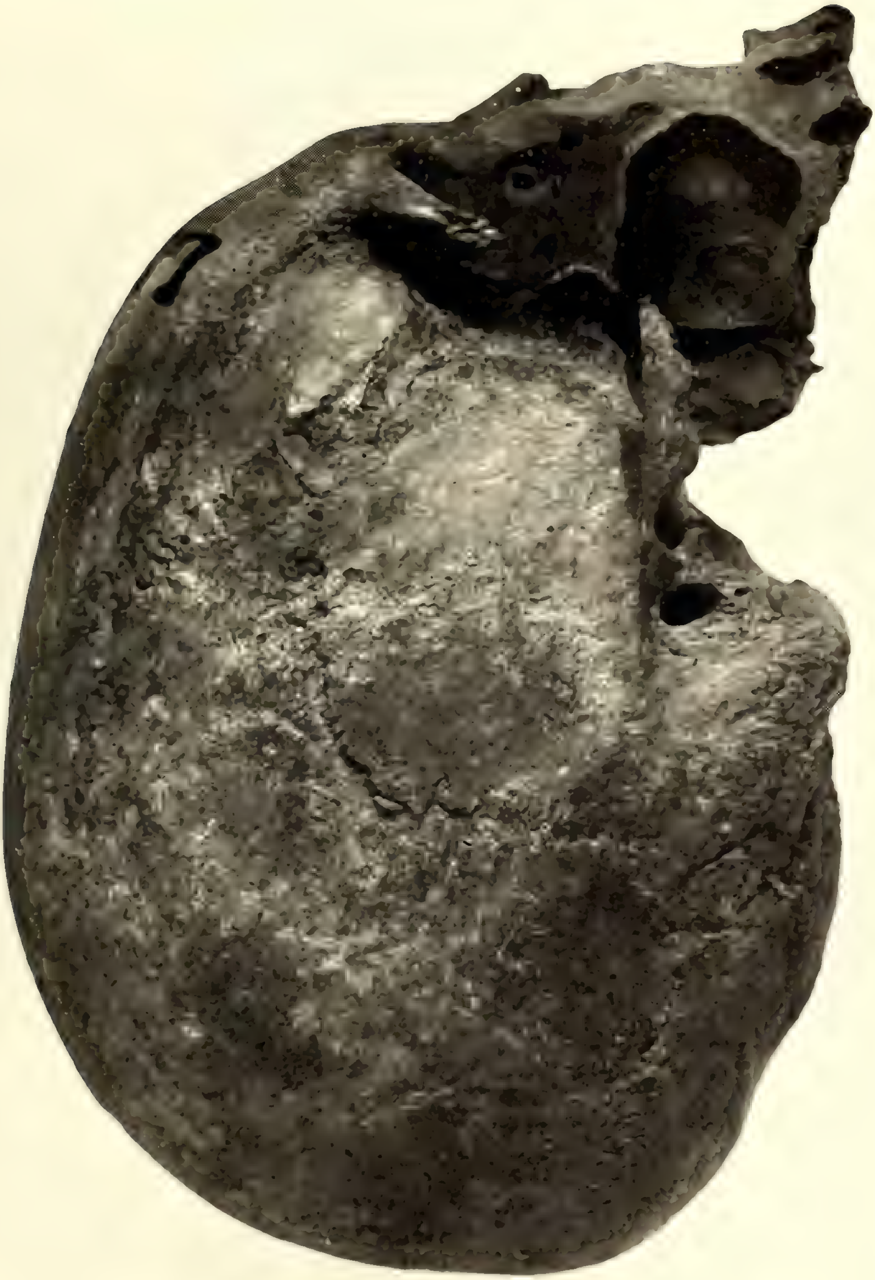
L. S. 120.



L. S. 63.

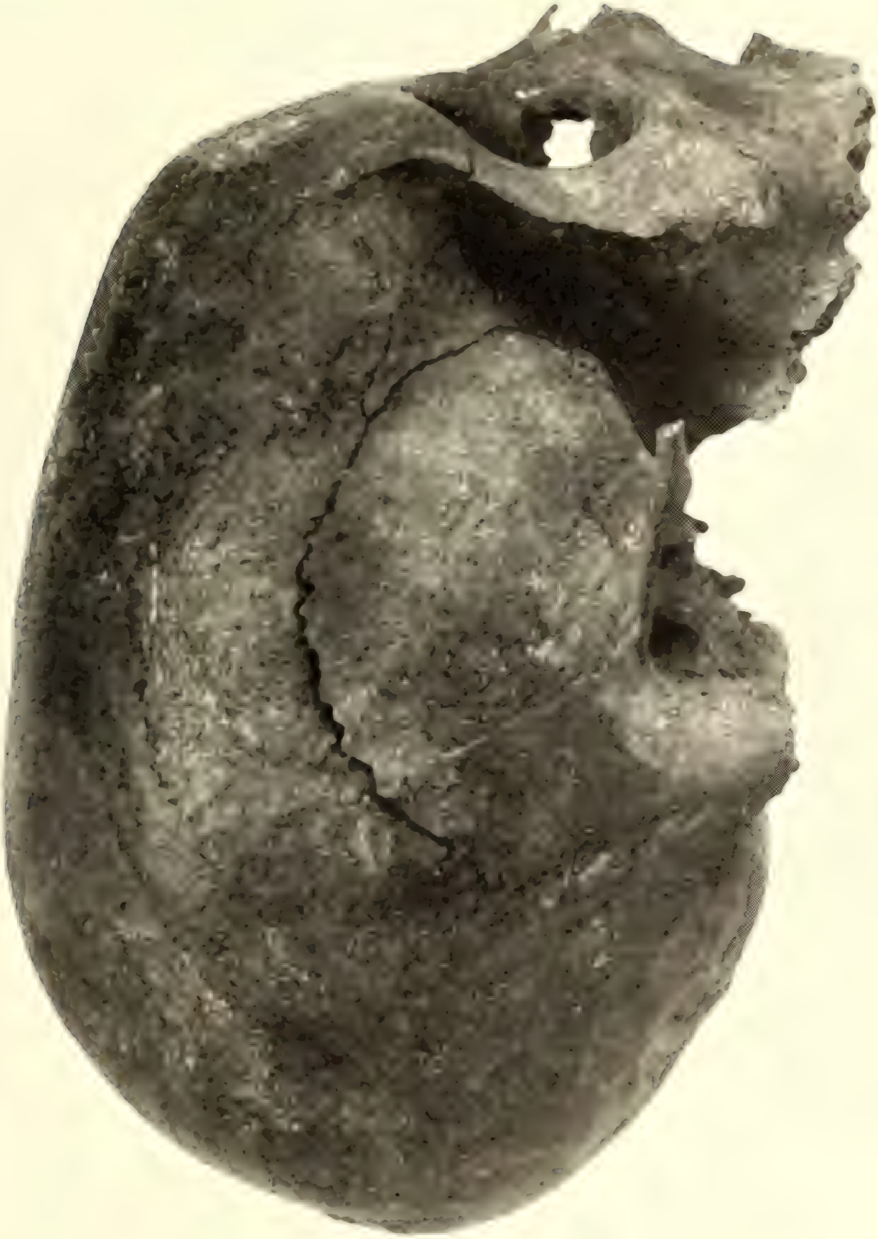
Typical Moorfields Cranium. Female.

Biometrika. Vol. V. Parts I and II. Plate XIV.



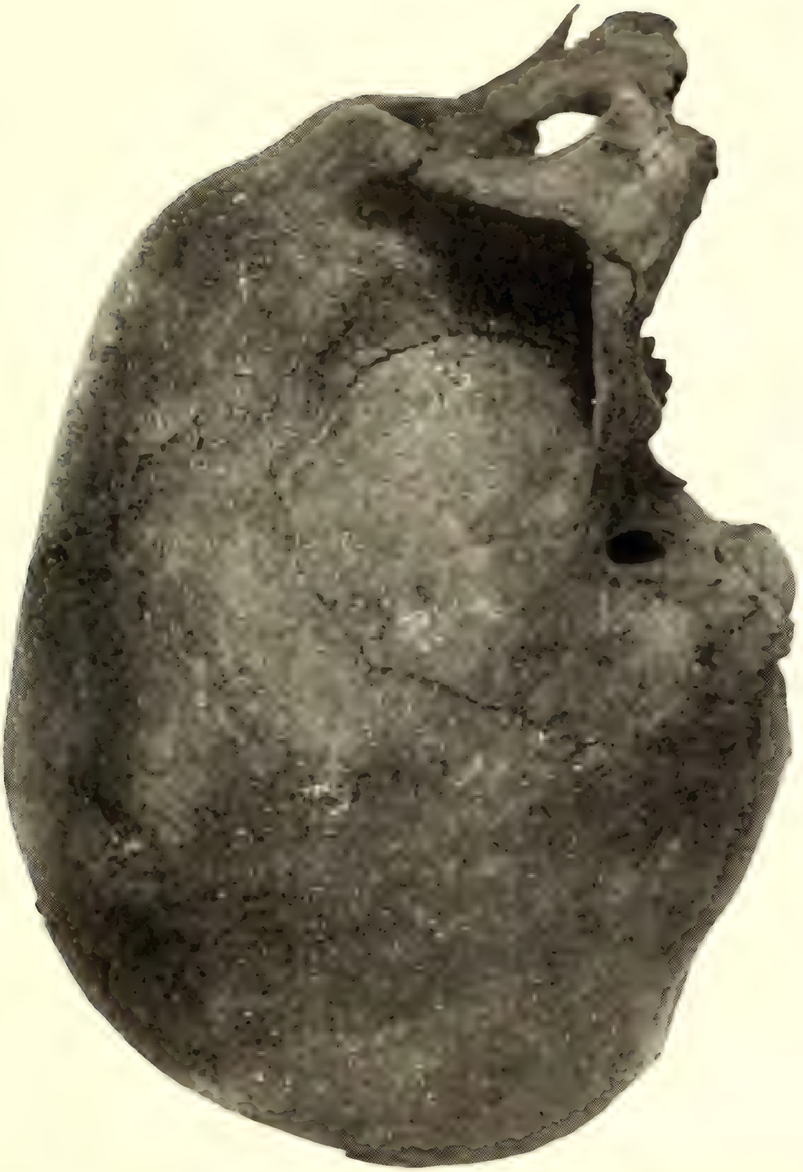
L. S. 101.

Typical Moorfields Cranium. Male.



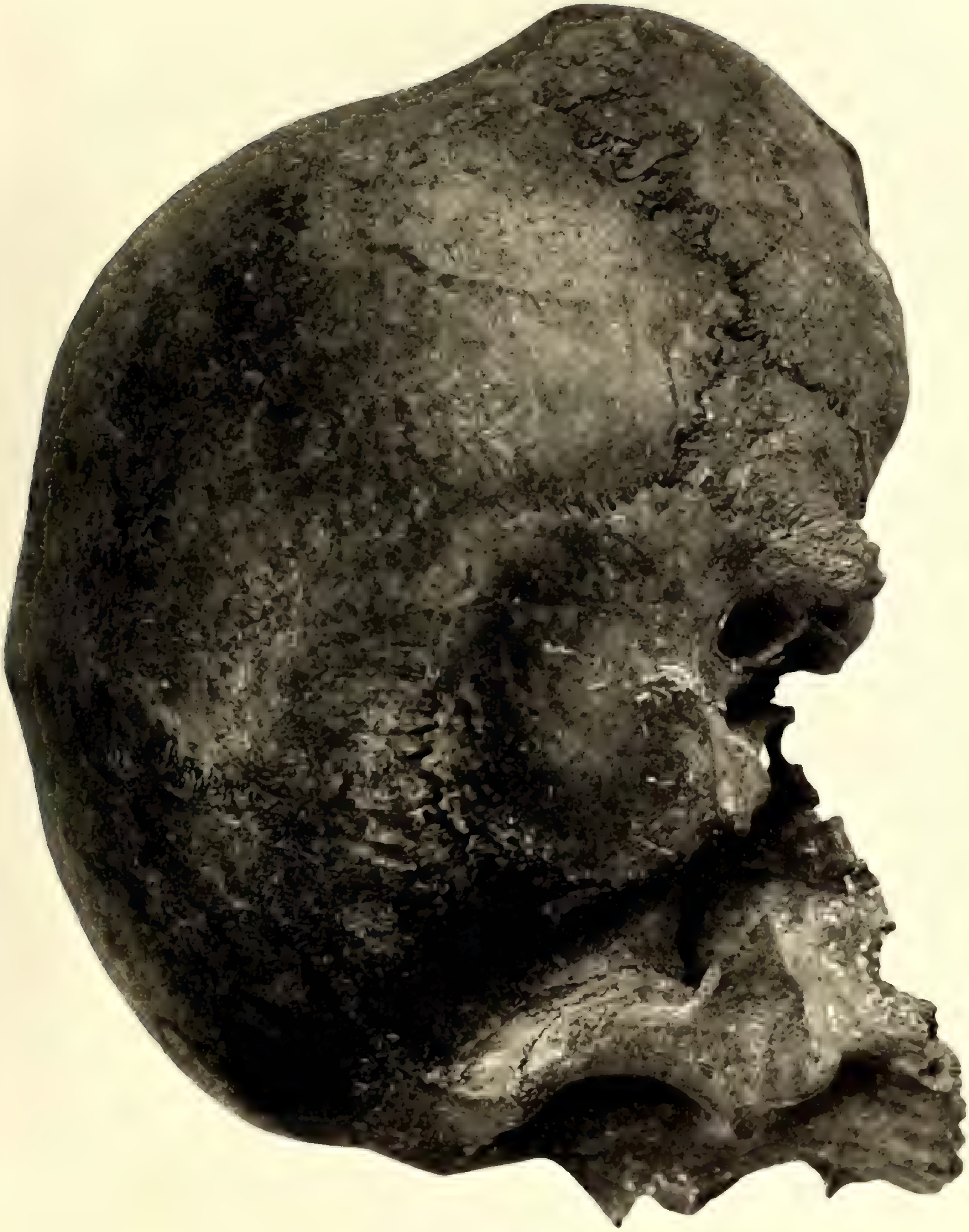
Typical Moorfields Cranium. Female.

I. S. 3.



L. S. 32.

Typical Moorfields Cranium. Female.



L. S. 99.

Moorfields Cranium. Male. Bathrocephaly.

Indices			
B/L	H/L	B/H	G'H/GB
4·4	69	107·7	78·1
7·3	68·6	112·6	61·9
6·8	69·7	110·1	—
—	67·8	—	—
4·2	68·1	109·1	—
4·5	71·7	104	—
4·6	64·9	114·9	76·5
2·1	66	109·3	71·9
6·1	65·6	116·1	67·7
3·2	69·2	105·8	—
3	68·2	106·9	—
3·6	—	—	—
3	64·3	113·5	—
—	—	—	—
6·7	—	—	—
9·5	—	—	—
5	69·5	122·4	—
7·3	73·5	105·1	—
4·4	—	—	—
1·1	73·5	110·4	—
2·1	68·5	105·3	—
3·4	71·2	103·2	—
2	70 4	116·5	—
3·9	—	—	—
3·9	65·2	113·4	—
4·7	65·8	113·6	—
1·2	64·5	110·2	—
6·4	61·8	123·8	—
—	—	—	—
0·2	70·2	100	—

MEASUREMENTS OF MOORFIELDS CRANIA.

TABLE I.

Series No	Sex	C	Lengths								Circumferences								Face									Palate		Indices											Angles						Foramen			Remarks
			F	L	L	B	B′	H	OH	LB	U	S	Q′	S_1	S_2	S	S	C	G′H	GB	J	NH	NB	O_1 L	O_1 R	O_2 L	O_2 R	G_1	G_2	B/L	H/L′	b/l	H/L	B/H	G′H/GB	NB/NH	O_2/O_1 L	O_2/O_1 R	G_2/G_1	GJ	N∠	A∠	B∠	θ_2	θ_1	P∠	fml	fmb	fmb/fml	
1	♂	1605	197	197	197	140·5	104	136	117	101·5	552	380	341	120	141	119	101	61·8	73	93·5	134·5	52·5	23	40·5	41	33	32	44·5	38·5	74·4	69	74·4	69	107·7	78·1	43·8	81·5	78	86·5	91·5	60·5	75·5	44	14	30	86·5	3·83	3·32	86·7	cal. ad. ossicle of bregma 18 × 12 mm. l. ossicle of pterion. coronal ridge, protuberant occipital. *torus occipitalis*
2	♂	1427	181	183·5	185	143	95	127	108	93	522	374	298	120	128	126	[illegible]	58·4	62·5	101		46	23	41·5	41·5	32	32	50	39	77·0	69·2	77·3	68·6	112·6	61·9	50	77·1	77·1	78	89·5	67	73	40	9	31	82	4·20	3·21	76·4	cal. ad. r. zygomatic defect. interparietal pentagonal fused with supra occipital. r. and l. triangular distinct. post parietal flattening. faint post coronal depression. marked inion. See Plate VI
3	♂ ?	1247	182·5	184	185	142	101	126	105	99	518	363	207	123	112	128	100	55·9	—	97	131			43·5		34·5	—		46	77·2	70·1	76·8	69·7	110·1	—		79·3										3·54	3·09	87·3	cal. old. face very defective. r. ossicle of pterion 43 mm. long, extending back in squamous suture. flattening of obelion
4	♀	-	186		188		100	127·5	111 *h*	101		375		127	123	125	104	59·9															67·8	—	—												3·25	2·72	83·6	cal. – f. ad. (? young). large basal and r. lateral defects. triangular ossicle 15 × 18 mm. in parietal notch of l. temporal. faint post coronal depression
5	♀	1425 ??	189		188	139·5	103·5	128	111·5 *h*	100	528	373	297	121	120	123	96	57·4									—					74·2	68·1	109·1	—						-						3·51	3·46	98·6	cal. – f. ad. (? young) with ethmoidal defect. flattening of obelion
6	♂	1586 ?	191·5		192·5	143·5	98	138	118 *h*	107	534	382	[illegible]	125	134	123	[illegible]	58·8												—		74·5	71·7	104	—												3·88	3·45	88·9	cal. – f. ad. (? young). spheno-ethmoidal defect. protuberant occipital and marked inion
7	♀	1309	182	184	185	138	95	120	103	105	505	345	295	107	125	113	92	58·2	70	91·5	128	51	23	42·5	43	38	38	47·5	37·5	75	65·2	74·6	64·9	114·9	76·5	45·1	89·4	88·4	78·9	101	67	73·5	39·5	15	30	83	3·81	3·31	90·0	cal. ad. base fractured. slight post coronal depression. slight protuberant occiput
8	♂ ?	1476	193·5	195	195·5	141	100	129	112	104	531	373	298	130	130	113	92	58·2	64	89		47·5	22	44·5	44	35	34	48	40	72·3	66·1	72·1	66	109·3	71·9	46·3	78·6	77·3	83·3	95	64	79	37	9	28	88	4·07	3·14	77·1	cal. ad. both zygomata defective. trs. fracture of base. slight depression of obelion. slightly prominent occiput
9	♀		179		180	137	89	118	107·5 *h*	84	500								55·5	82 ?		46	22	[illegible]		[illegible]		41	37·5			76·1	65·6	116·1	67·7	47·8	80		91·5	70	62	77·5	40·5					3·35		cal. ad. large occipital and r. temporal defect. apex of occipital prolonged (linguiform process). obelion grooved. faint post coronal depression. two small precondylar eminences
10	♀		173·5		173·5	127	93	120	107·5	90	482	345		126	118	98	83	62·3	64	—		47	23·5		41		32			—		73·2	69·2	105·8		50		78		90	65	75	40				3·43	2·45	71·4	cal. ad. very defective
11	♂	1450 ?	186·5	186	189	138	96	129	117	[illegible]	516	383	310	135	141	107	86	57·3						39·5		33				73	68·2	73	68·2	106·9			83·5										3·43	3·04	88·6	cal. – f. with left orbit. ad. slight post coronal depression ossicles in lambdoid suture (horizontal foramen in l. spinous sphenoid. imperfect *porus crotaphitico-buccinatorius*). slight *torus occipitalis*
12	♀		178	180·5	180	132·5	95		112	—	498	364	293	123	110	122	102·5	60·8			126·5			38		[illegible]				73·4		73·6	—	—	—		[illegible]										3·35			cal. – f. with orbits. ad. (? young) with large basal defect. slight sagittal ridge and linguiform process on occipital. slightly protuberant occiput
13	♂ ?	1425	188	190	190·5	139	93	122·5	110	95	522	387	297	123	130	128	101	56·3	72	—		50			42		32·5			73·2	64·5	73	64·3	113·5				77·4		87·5	61·5	72·5	46	17·5	28·5	90	3·20	2·73	85·3	cal. ad. left half of face wanting. faint post coronal depression.
14	♀		183		184		98		115										62	—		48	25·5		41		29·5							—	—	53·1		71·9												cal. ad. very imperfect—whole base. post coronal flattening on r. side
15	♀		170·5		178	136·5	91				493	345				-	111	88	50·0													76·7									–									dome. ? old. marked groove of obelion. protuberant occiput
16	♀		172 ?		171 ?	136 ?	90 ?		104 *h*																							79·5	—	—	—															dome. ? old. occipital torus
17	♀	1480 ?	177	176	177	150·5	97	123	117	91	520	370	342	132	119	110	96	59·8	62			40·5			40		32·5	-		85·5	69·9	85	69·5	122·4	—			81·2		90·5	75·5	66	38·5				3·4			cal. ad. left half of face wanting and l. occipital defect. post-coronal depression. slight *torus occipitalis*
18	♀		182		185	143	96	136	118 *h*	[illegible]		385	[illegible]	125	[illegible]	131	104	50·0														77·3	73·5	105·1	—						—						3·01	2·83	94·0	cal. – f. ad. large l. fronto-temporal defect. metopic. *sharp* occipital torus. two ossicles in right extremity of lambdoid suture
19	♂ ?		190·5		191	142	99		111 *h*	-	528	[illegible]		127	137	104	87	60·3														74·3		—																cal. – f. ad. very imperfect base. prominent occiput. traces of ossicle of λ
20	♀		175		177·5	144	96	130·5	113 *h*	95·5	505 ?	305		125					67		124	49	24·5		43		32·5	45	36			81·1	73·5	110·4	—	50		75·6	80	90	64·5	73·5	42				3·20	2·92	91·2	cal. ad. (? old). r. parietal, l. temporal and l. malar defects. post coronal depression. ossicle of asterion in part fused and triangular ossicle 15 × 12 mm. in parietal notch of temporal both on r. side (masto-squamosal suture)
21	♀		181		182·5	131·5	87·5	125	110 *h*	[illegible]	500	[illegible]	201		120	110	95	64·0														72·1	68·5	105·3													3·50	2·70	78·0	cal. – f. ad. with sphenoidal defect. slight post coronal constriction. post parietal flattening. slightly protuberant occiput
22	♀	–	178		177	130	93·5	126	112 *h*	93 ?	496	358 ?	289	123	133	102	87	62·4			—						—			—	—	73·4	71·2	103·2							—						3·39	3·03	89·4	cal. – f. ad. fronto-sphenoidal defect. slightly protuberant occipital
23	♂	1070	187		189	155	104	133	122 *h*	98	545	387	[illegible]	130	[illegible]	122	97	56·7			—								–	—	—	82	70·4	116·5	—					—	—						3·82	2·91	76·2	cal. – f. ad. ossicles in lambdoid suture
24	♀		185		184	136	96		107 *h*		512										—									—	—	73·9	—	—	—						—									dome. ad. ? old. slight flattening of obelion. slight *torus occipitalis*
25	♀ ?	1400	185		184	136	87	120	100 *h*	88·5	515	[illegible]	288	125	127	124	96	[illegible]										—		—	—	73·9	65·2	113·4	—												3·34	2·55	76·3	cal. f. child. distinct post coronal depression. numerous ossicles in lambdoid suture, on r. side one of 12 and one of 16 mm. triangular ossicle in parietal notch of r. temporal. l. ossicle of pterion. imperfect *porus crotaphitico-buccinatorius* and horizontal foramen in spinous sphenoid both sides
26	♀		190·5		190	142	100	125	113 *h*	96·5	531	374	305	122	128	124	95·5	55·3												—	—	74·7	65·8	113·6	—						—						3·70	2·87	77·7	cal – f. ad. with fronto-ethmoidal defect. rather prominent occipital
27	♂ ?	1207 ?	187	189	189	134·5	94	122	102	100	512	370	280	120	129	115	94·5	58·8	66			50	24	41		33		–	37·5	71·2	64·5	71·2	64·5	110·2	—	48	80·5	—		94	65	75·5	39·5	15·5	30	85	3·20	2·70	84·4	cal ad r. malar, temporal, occipital and l. zygomatic defects. distinct post coronal constriction. slight depression of obelion. flattening of post parietal region. slightly plagiocephalic
28	♀	1476	191		191	146	97	118	114 *h*	93	537	385	302	127	133	125	101	57·7												—	—	76·4	61·8	123·8	—												3·47	2·79	80·4	cal. – f. old. prominent occiput. traces of ossicle of λ and considerable wormian in l. lambdoid suture. shallow groove of obelion
29	♂	-	192		195		100		108 *h*		—			122	129				-								—			—	—	—	—	—	—		—		—											dome. ad. posterior sagitt. grooving
30	♂ ??		182		186·5	131	95	131	111 *h*	103	505	308	286	116	130	110	94	57·8										—		—	—	70·2	70·2	100	—						—						3·27	3·01	92	cal. – f. ? old. with large fronto-sphenoidal defect. faint post coronal depression

Indices		
H/L	*B/H*	*G'H/GB*
66·8	111·8	—
68	106·3	—
—	—	—
—	—	—
71	104·8	—
73·4	103·2	80·2
68·8	111·6	73·8
64	125·6	69·3
70·1	105·5	70·2
—	—	—
68·6	110·1	—
—	—	—
—	—	—
—	—	80·7
—	—	—
—	—	—
—	—	74·1
—	—	—
—	—	—
—	—	—
—	—	—
—	—	—
74·3	112·5	—
61·1	122·8	—
—	—	—
—	—	68·6
67·4	109·2	77·5
61·8	113·8	—
—	—	—
64·5	113·4	—
—	—	67·2
—	—	—
61·1	121·1	78

MEASUREMENTS OF MOORFIELDS CRANIA.

TABLE II.

Series No.	Sex	C	Lengths								Circumferences								Face									Palate		Indices											Angles						Foramen			Remarks
			F	L	L	B	B'	H	OH	LB	U	S	Q	S_1	S_2	S_3	S_4	C C	GH	GB	J	NH	NB	O_1 L	O_1 R	O_2 L	O_2 R	G_1	G_2	B/L	H/L	B/L	H/L	B/H	GH/GB	NB/NH	O_2/O_1 L	O_2/O_1 R	G_2/G_1	GI	N∠	A∠	B∠	θ_2	n_1	P∠	fml	fmb	$\frac{fmb}{fml}$	
31	♀?		182		184	137·5	94	123	105 h	97	500	356		118	127	114	93·5	55·7					—						—	—		74·7	66·8	111·8					—								3·84			cal. f. ad. with large defect base and l. side. metopic ridge. slight occipital prominence. *torus* 23 mm. above inion. trace of transverse occipital suture between the two eminences
32	♀	—	170	—	175	126·5	87	119	105 h	86	474	351	—	121	117	113	97	63·2	—	—	—	—	—	—	40	—	35·5	—	—	—	—	72·3	68	106·3	—	—	—	88·7	—	—	—	—	—	—	—	—	3·59	2·89	80·5	cal. – f. y. ad. with r. orbit. l. temporo-sphenoidal defect. precoronal depression. See Plate XVI
33	♂?	—	183	—	184	138	100	—	110 h	—	514	—	—	120	120	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	75	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	dome. ad. protuberant occiput
34	♀	—	199	—	198	150	103	—	118 h	—	560??	399	—	138	137	124	99	56·9	—	—	—	—	—	—	—	—	—	—	—	—	—	75·8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	cal. – f. ad. very defective base. flattening of obelion. protuberant occipital. slight occipital *torus*
35	♀	—	177	—	176?	131	98	125?	108 h	—	498	—	286	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	74·4	71	104·8	—	—	—	—	—	—	—	—	—	—	—	—	—	3·07?	—	cal. – f. ad. defective base. metopic
36	[illegible]	1202	174	173	173	131	[illegible]	127	107	95	490	348	284	125	106	117	95	58·0	69	86	120	52	24	39	39	32·5	34	43	35·5	75·7	73·4	75·7	73·4	103·2	80·2	46·1	83·3	87·2	82·6	89	63·5°	72·5°	44°	13·5°	30·5°	86°	3·09	2·58	83·5	cal. y. ad. gap in l. temporal fossa. ossicle of λ 25 × 30 mm. r. ossicle of pterion 35 × 10 mm. r. paroccipital process 12 mm. long articulating with atlas. on l. jugular process a small articular facet. teeth present. r. lat. incisive canine. l. canine tooth descending behind lateral incisor (cf. Whitechapel 7041). post sagittal groove. r. nearly complete *porus crotaphitico-buccinatorius*. See Plates VII and X
37	[illegible]	1121	170	169	170	130·5	92	117	101	90	481	340	278	116	113	111	90·5	58·3	60·5	82	114·5	43·5	21	41	41·5	32·5	32	39	31·5	77·2	69·2	76·8	68·8	111·6	73·8	48·3	79·3	77·1	80·8	86·5	67°	73°	40°	12°	28°	85°	3·13	2·62	83·7	cal. old. slight post coronal depression. r. *foramen jugulare spurium*
38	[illegible]	1541	188	188	189	152	98	121	111·5	96	540	376	315	131	130	115	91·5	56·8	66·5	96	—	52·5	28·5	40·5	41·5	33	33·5	—	41·5	80·8	64·4	80·4	64	125·6	69·3	54·3	81·5	80·7	—	91·5	65·5°	73°	41·5°	14°	27·5°	87	3·56	3·04	85·4	cal. y. ad. r. zygoma defective. frontal process to temporal. slight bathrocephaly. 4 wormians in lambdoid suture. r. ossicle of asterion. premolar and molar range markedly convex downwards
39	♂	1304	184	183	184	136	95	129	100	90	510	372	295	124	108	140	111·5	56·8	69·5	99	122·5	50	25	40	40·5	32·5	32	47	37·5	74·3	70·5	73·9	70·1	105·5	70·2	50	81·2	79	79·8	97·5	68°	70·5°	41·5°	10·5°	31°	81°	3·02	2·72	90·1	cal. ad. small posterior parietal and maxillary defects on l. side. slight depression of obelion
40	♂	—	178	—	181	143?	93	—	?	91	515	361	295?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	79	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3·73	3·05	81·8	cal. – f. ?old. fronto-ethmoidal defect
41	♂	—	187	—	188	142	101	129	112 h	98	525	385	305	134	135	116	95	58·6	—	—	—	—	—	—	—	—	—	—	—	—	—	75·5	68·6	110·1	—	—	—	—	—	—	—	—	—	—	—	—	3·25	3·16	97·2	cal. – f. ad. spheno-ethmoidal defect. small l. parietal. post coronal depression. frontal process to temporal on both sides. slight sagittal ridge. traces of transverse occipital suture on each side
42		—	194	—	—	140·5	99	—	121 h	—	534	—	—	—	136	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	dome. ?old. slight bathrocephaly. no wormian to be recognised in lambdoid suture
43	♀	—	184	—	190	—	91	?	—	—	515?	365	—	?	?	?	?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	dome. old. slight bathrocephaly. lambdoid suture closed
44	[illegible]						[illegible]	[illegible]	[illegible]	[illegible]				132					75	93		56	22·5	43	43·5	37·5	39	55	—	—	—	—	—	—	80·7	40·2	87·2	89·7	—	100·5	66·5°	70·5°	43°	—	—	—	—	—	—	cal. ?ad. extensive defect of hinder part and r. side. faint post coronal depression. l. ossicle of pterion
45	[illegible]					[illegible]	[illegible]					[illegible]		133	[illegible]	125	101	57·6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		—	dome. ad.
46	♀	—	181	—	181	142	95	—	—	—	518	354	—	125	115	114	93·5	58·7	—	—	—	—	—	—	—	—	—	—	—	—	—	78·4	—	—	—	—	—	—	—											dome. ad. slight *torus occipitalis*
47	[illegible]		180	[illegible]	181		[illegible]		[illegible]				290	132	[illegible]				63	85		45·5	23·5	38	38	32	32·5	45	[illegible]						74·1	[illegible]	[illegible]	[illegible]	[illegible]							83			—	cal. y. ad. large occipital and l. parietal fracture. slight depression of obelion
48	[illegible]		180		191	135·5	[illegible]		[illegible]		[illegible]	374		126	133	115	95	59·2	—	—	—	—	—	—	—	—	—	—	—	—	—	70·9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	dome. ?old
49	♂?	—	—	—	—	—	—	140	117 h	—	—	—	312?	—	135?	115	97·5	61·7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3·48	3·19	91·7	hinder part of cranium. ?old. sharp occipital *torus* 35 mm. long
50	[illegible]		179		[illegible]	[illegible]	[illegible]		114 h		[illegible]	301		129	121	111	[illegible]	[illegible]	—	—	—	—	—	—	—	—	—	—	—	—	—	70·9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3·00	—	dome. ?old
51	♂	—	195	—	198	145·5	94·5	—	—	—	—	—	—	141	125	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	73·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	dome. ad. ossicle of bregma (between parietals) 23 × 10 mm. rather sharp occipital *torus* 35 mm. long
52			179	—	181	—	89	—	—	—	—	—	—	123	113	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	dome. ad. ?young. post coronal depression. linguiform process to occipital. slight *torus occipitalis*
53	♂	—	183?	—	183?	153	94	136	112 h	90·5	—	393?	—	129	129	135	110	58·2	—	—	—	—	—	—	—	—	—	—	—	—	—	83·6	74·3	112·5	—	—	—	—	—	—	—	—	—	—	—	—	3·45	3·00	86·9	cal. – f. ad. l. temporal defect and extensive fracture. small ossicles in r. lambdoid. faint post coronal depression
54	♂	—	190	—	193	145	96	118	110 h	93·5	—	386	303	133	130	123?	95·5	55·6	—	—	—	—	—	—	—	—	—	—	—	—	—	75·1	61·1	122·8	—	—	—	—	—	—	—	—	—	—	—	—	3·60	2·72	75·6	cal. – f. ad. large r. occipito-parietal defect. slight r. post coronal depression
55	♀	—	180	—	184	136	96	—	108 h	—	500	—	—	119	121	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	73·9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	dome. ad.
56	[illegible]		188·5	—	191·5	148	99	—	116 h	—	531?	380	—	130	136	112	97	64·4	64·5	94	—	49	22	42	44	31	32·5	45·5	36·5	—	—	77·3	—	—	68·6	44·9	73·8	73·9	80·2	—	—	—	—	—	—	—	—	—	—	cal. ad. large occipital and r. temporal defect and defect of vertex. triple ossicle of λ collectively 40 × 30 mm. individually 25 × 20, 25 × 15, 15 × 6 mm. bilateral ossicle 10 × 12 mm. at outer end of lambdoid. See Plate VIII
57	♀	1405	185	186·5	187	137·5	98	126	111	96	523	370	304	125	127	118	93	56·3	69	89	121	48	19·5	42	41	34·5	34·5	48	36·5	73·7	67·6	73·5	67·4	100·2	77·5	40·6	82·1	84·1	76	93·5	67°	70·5°	42·5°	13°	29·5°	83·5°	3·55	2·64	74·4	cal. ad. traces of ossicles in lambdoid. retained and displaced r. canine. slight *torus occipitalis*
58	♀	—	193	—	195	137	98	120·5	114 h	96	534	373	303	140	114	119	95	56·9	—	—	—	—	—	—	—	—	—	—	—	—	—	70·3	61·8	113·8	—	—	—	—	—	—	—	—	—	—	—	—	4·18	3·46	82·8	cal. – f. y. ad. spheno-ethmoidal defect. bathrocephaly. numerous ossicles in lambdoid and r. masto-parietal sutures
59	♀	—	—	—	—	145·5	—	—	—	—	—	—	—	—	122	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	dome. y. ad. very imperfect. post coronal depression
60	♀	1308	184	—	186	136	96	120?	106 h	97	518	363	—	126	123	114	92	57·6	—	—	—	—	—	—	—	—	—	—	—	—	—	73·1	64·5	113·4	—	—	—	—	—	—	—	—	—	—	—	—	3·37	2·70	80·1	cal. – f. ad. small spheno-ethmoidal defect. slightly prominent occiput. small *torus occipitalis*
61	[illegible]		187	186	186·5	—	—	—	—	97	—	—	—	—	—	124	105	61·6	64·5	96	133	51	26	41·5	42	29	29·5	50·5	41·5						67·2	51	69·9	70·2	82·2	98·5	72	69·5	38·5	14·5	24	84	3·85	[illegible]	70·6	cal. ad. greater part of calvaria wanting
62	[illegible]							[illegible]						142	[illegible]																																3·17	2·62	82·6	dome. y. ad. with small part of base
63	[illegible]	1531	197	197·5	198	146·5	[illegible]	121	[illegible]	[illegible]	[illegible]	387	295	129	[illegible]	125	[illegible]	56·5	64	82	125	47	23	41	39·5	31·5	32	48	38·5	74·2	61·3	74	61·1	121·1	78	48·9	76·8	81	80·2	99	70·5°	72°	37·5°	11°	26·5°	83°	3·41	2·78	81·5	cal. ad. faint post coronal depression, faint bathrocephaly. small ossicles in lambdoid suture, one 25 × 15 mm. to left of λ. bilateral ossicle in occipito-mastoid suture. l. *porus crotaphitico-buccinatorius*. infra orbital suture on face. See Plate XIII

LDS CRANIA.

INDICES			
B/L	H/L	B/H	G'H/
4·2	68·3	108·7	76·9
4·8	65·4	114·3	—
6	—	—	—
5·1	—	—	—
7·1	65·6	117·6	—
5·7	67	112·9	81·2
—	—	—	76·9
6·8	—	—	—
2·8	65·8	110·5	73·6
—	—	—	—
2	67·2	107·2	68·7
6	65	116·8	—
4·4	—	—	—
1·8	68·8	104·5	73·4
3·7	—	—	—
5·6	67·2	112·4	71·2
6·2	—	—	—
6	70·7	107·4	—
—	—	115·9	—
—	61·5	—	—
6·9	73·1	105·3	—
77·2	—	—	—
74·2	69·4	106·8	70·
76·4	74·8	102·1	77·
74·7	69·6	107·3	79
72·9	67·5	108	—
77·5	—	—	—
71·7	64·7	111	—
76·9	68·7	112	—
77·6	70·7	109·6	—
74·9	67·9	110·2	72·
74	63	117·5	—
72·6	—	—	—
74	68	108·7	70
74·3	70·3	105·8	—

r angles.

Series No.	Sex	C	Lengths								Circumferences								Face									Palate		Indices											Angles						Foramen			Remarks
			F	F'	L	B	B'	H	OH	LB	U	S	Q	S_1	S_2	S_3	S_3'	$C.C$	$G'H$	GB	J	NH	NB	O_1 L	O_1 R	O_2 L	O_2 R	G_1	G_2	B/L'	H/L'	B/L	H/L	B/H	$G'H/GB$	NB/NH	O_2/O_1 L	O_2/O_1 R	G_2/G_1	GL	$N\angle$	$A\angle$	$B\angle$	θ_2	θ_1	$P\angle$	fml	fmb	fmb/fml	
64	[illegible]	1440	183	184	184·5	137	98	126	111	95	515	375	302	121	120	129	103·5	57·2	71·5	93	131	53·5	22	40	40	35	30	46	41	74·5	68·5	74·2	68·3	108·7	76·9	41·1	87·5	[illegible]	89·1	92	65	70	45	14	31	81	3·51	3·15	89·7	cal. ad slight occipital projection. large ossicles at apical portion of lambdoid suture bilateral ossicle of pterion
65	[illegible]	1470	189·5	—	192·5	144	96·5	126	114 *h*	97	533	383	302	140	125	118	93	56·3	—	—	—	—	—	—	—	—	—	—	—	—	—	74·8	65·4	114·3	—	—	—	—	—	—	—	—	—	—	—	—	3·54	2·86	80·8	cal. – f. ad. slight occipital projection. faint post coronal depression *torus occipitalis* 35 mm long
66	[illegible]	1425	170		181	137·5	95·5			97	[illegible]	365	307?	[illegible]		110	[illegible]	[illegible]												—		76															3·68	2·94	79·9	cal. f. ad fractured l. parietal. slight bathrocephaly. large ossicle of bregma 63 × 50 mm. nearly symmetrical, mostly between parietals. r. ossicle of pterion. See Plate IX
67	[illegible]		192	—	195	146·5	106	—	115 *h*	—	540	383	—	139	130	114	95	60·0	—	—	—	—	—	—	—	—	—	—	—	—	—	75·1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	dome ad. slight bathrocephaly. no ossicles in λ. faint *torus occipitalis* slight post coronal depression
68	[illegible]	1384	185	185	186	143·5	[illegible]	122	[illegible]	94·5	[illegible]	[illegible]	[illegible]	127							120			40·5		35				77·6	65·9	77·1	65·6	117·6			86·4									–	3·37	[illegible]	86·9	cal f ad with l. orbit bathrocephaly numerous large ossicles in lambdoid. suggestion of *torus occipitalis*
69	[illegible]	1227	177	179	179	135·5	87	120?	[illegible]	96	500	352	273?	?	?	?	?		62·5	77?	122	48·5	26	41	41·5	31·5	32		32·5	75·7	67	75·7	67	[illegible]	81·2	53·6	76·8	77·1		83·5	63·5	74·5°	42°	15·5°	26·5°	[illegible]	3·38	[illegible]	89·3	cal ad depression of [illegible] r fronto-squamous contact l. ossicle of pterion
70 †	[illegible]					142·5	98		110?	101									70	[illegible]	128	53·5	26·5	41	43	35	35	47	41	—					76·9	[illegible]	85·4	81·4	87·2	96	65·5°	73°	41·5°	[illegible]	31·5°	83°	[illegible]	[illegible]	82·5	cal ad occipital and bregmatic defects slight *torus occipitalis*
71	[illegible]		184		185	142	94·5		[illegible] *h*		[illegible]	[illegible]	[illegible]	[illegible]	135	117	93	[illegible]													—	76·8																		dome. ad. faint post coronal depression (anterior half of sagittal faintly ridged and posterior faintly grooved). trace of occipital *torus*
72	[illegible]	1643	201	202	202	147	104	133	117	100	558	408	312	135?	[illegible]	[illegible]	107	57·4	67	91	132	49	28	43	41·5	32	32·5	55·5	40?	72·8	65·8	72·8	65·8	110·5	73·6	57·1	74·4	[illegible]	72·1	97·5	68°	72·5°	39·5°	12·5	27°	85	3·45	[illegible]	85·5	cal. ad. slight temporal defects bilateral slight occipital prominence
73 †	♀	—	—	—	—	—	97	—	110 *h*	-	—	—	—	130	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	dome. ad. with small part of base
74	[illegible]	1313	186·5	186	186	134	95	125	108	98	511	373	287	124	126	113	96	61·9	61·5	89·5	120	45	23·5	41	41	31	32	48	36	72	67·2	72	67·2	107·2	68·7	52·2	75·6	78	75	95·5	69°	74°	37°	9°	28	83°	3·28	2·69	82	cal. ad. faint pre coronal depression
75	♂	—	177	—	183	139	92	119	110·5 *h*	92	—	357	—	124	120	113	90	56·8	—	—	—	—	—	—	—	—	—	—	—	—	—	76	65	116·8	—	—	—	—	—	—	—	—	—	—	—	—	3·55	3·05	85·9	dome. ad. with occipital. slight occipital prominence. sagittal faintly grooved posteriorly
76	♀	—	178·5	—	182	135·5	—	—	—	94	—	367	302	?	?	?	?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	74·4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3·77	3·25	86·2	dome ? old with occipital
77	[illegible]	1648	197·5	199·5	197	141·5	103	135·5	117	102	546	402	312	[illegible]	128?	144?	111	55·3	67·5	92		50·5	22·5	41·5	42·5	32·5	32·5	51	41	72	[illegible]	71·8	68·8	104·5	73·4	44·6	[illegible]	[illegible]	80·4	95·5	65	75·5	[illegible]	[illegible]	[illegible]	85	[illegible]	2·57	79·5	cal ad r zygoma defective ossicle of λ 15 × 13 mm slight *torus occip* 35 mm
78	[illegible]		179	178	178·5	131·5?	[illegible]			102·5	497					116	92	[illegible]	63		116·5	40·5	20·5		40		32		30	73·9		73·7				[illegible]		[illegible]		99	[illegible]	75	[illegible]	[illegible]	27·5	84	3·18	2·66	83·6	cal v ad bregmatic and l malar defect
79	[illegible]	1170	173	174	174	131·5	87·5	117	[illegible]	95	492	351	280	125	120	97	85	[illegible]	57	80	116	44	23·5	39·5	[illegible]	[illegible]	29·5	45·5	39	75·6	67·2	75·6	67·2	112·4	71·2	53·4	74·7	74·7	85·7	[illegible]	67·5	77	33·5	8	27·5	85	3·01	[illegible]	[illegible]	ca. ad suggestion of occipital *torus*, marked occipital asymmetry
80	[illegible]		191·5		193	147			[illegible]		[illegible]	370		[illegible]	120	126	102	57·8														76·2																		dome. ad slight *torus occipitalis*
81	[illegible]?	1278	179	—	181	137·5	102	128	110 *h*	104	502	351	295	124	117	110	90	58·5	—	—	—	—	—	—	—	—	—	—	—	—	—	76	70·7	107·4	—	—	—	—	—	—	—	—	—	—	—	—	3·09	2·91	94·2	cal. – f. ad.
82	♂	—	182?	—	—	149·5	106	129	117 *h*?	—	—	—	318??	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	115·9	—	—	—	—	—	—	—	—	—	—	—	—	3·51	3·10	88·3	cal. – f. ad. large fronto-sphenoidal defect slight prominence of occiput faint post coronal depression traces of ossicle 20 × 20 mm. in r. lambdoid
83	[illegible]	1237?	184	187	187	—	97·5	115	101	97·5		358	282?	120	112	117	97	59·5	63			46			41		32			-	61·5		61·5					78		91	65°	76°	36°			-	3·11			cal old l half face parietal and basal defects shallow posterior sagittal groove protuberant occiput. See Plate XV
84	[illegible]	1399	178·5		182	140	[illegible]	133	121 *h*	[illegible]	515	371	322	[illegible]	131	111	94·5	62·2														76·9	73·1	105·3			-	—	—	—	—	—	—	—	—	—	3·56	2·74	77·0	cal. – f. y. ad. small r. temporal defect. slight bathrocephaly. small wormians in lambdoid trace of *torus occipitalis*
85	[illegible]		178	—	179·5	138·5	97	—	111 *h*	-	509	346	—	118	?	?	?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	77·2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	dome. ad.
86	[illegible]	1247	179·5	179	180	133·5	93	125	109	97·5	498	356	285	124	124	108	91	61·1	61	86	122	46·5	24·5	38·5	39·5	30	30·5	38·5	37	74·6	69·8	74·2	69·4	106·8	70·9	52·7	77·9	77·2	96·1	80·5	64°	78·5°	37·5°	12·5°	25°	91°	3·66	[illegible]	82·8	cal v. ad occipital rather prominent
87	[illegible]	[illegible]	[illegible]	[illegible]	188·5	144	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	321	[illegible]	139	118	[illegible]	62·2	71·5	[illegible]		51	23·5	41	42	31	32	50	38	76·6	75	76·4	74·8	102·1	77·3	46·1	75·6	76·2	76	101·5	66·5	73·5	40	13	27	86·5	3·11	3·02	97·1	cal. ad bilateral zygomatic defects slight *torus occipitalis*
88*		-	170	[illegible]	168	125·5	[illegible]	117	[illegible]	[illegible]	[illegible]	348	292	[illegible]	129	101	88	65·3	58·5	74	99	40	21	36·5	36·5	33	34	[illegible]		74·7	69·6	74·7	69·6	107·3	79	52·5	[illegible]	93·2		78	64	73·5	42·5	13·5	29	87	[illegible]	[illegible]	78·5	cal child about 5 or 6 years, faint post coronal depression. teeth *in situ* 7 and 2 temp. molars each side 1st permanent molar and mesial incisor just coming down
89	♀	1440	194·5	—	194	141·5	102	131	116 *h*	97	549	396	315	136	126	134	107	56·9	—	—	—	—	—	—	—	—	—	—	—	—	—	72·9	67·5	108	—	-	—	—	—	—	—	—	—	—	—	—	3·36	3·30	98·2	cal f ad small ethmoidal defect metopic slightly prominent occiput. faint post coronal depression
90	♂	—	188	—	189	146·5	99	—	119 *h*	—	532	381	—	138	124	119	99	59·8	—	—	—	—	—	—	—	—	—	—	—	—	—	77·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	dome. ad. slightly prominent occipital. small ossicles in lambdoid suture
91	♀	—	182	—	184	132	97	119	107·5 *h*	98	—	360	285	116	122	120	101	61·0	—	—		—	—	-		—				—		71·7	64·7	111							—			-		-	3·05	2·66	87·2	cal. f ad l temporo-sphenoidal defect post coronal depression. protuberant occipital
92	♀	1415	182	181	182	140	96	125	111	95	514	372	299	126	127	110	97	58·2	62	—	-	44·5	22	41·5		32·5	—	48·5	39	77·3	66·1	76·9	68·7	112		49·4	78·3		80·4	93·5	60·5°	72°	38·5°	12·5°	26°	84·5°	3·40	2·76	81·2	cal. ad r malar defective faint post coronal depression ossicle in parietal notch of r. temporal
93	♂	—	188	189	189·5	147	97	134	118	100	535	380	319	132	130?	118?	95	57·4	—						44·5		32			77·8	70·9	77·6	70·7	109·6				71·9	-	-	—						3·22	2·80	86·9	cal. – f. ad. (? old) with r. orbit large l spheno temporal defect and small l. frontal defect
94	♂	1415	184	187	187	140	98	127	104	97·5	518	373	290	124	126	123	99	57·4	74·5	103	—	53	23·5	43	44	33	—	51	41	74·9	67·9	74·9	67·9	110·2	72·3	44·3	76·7	—	80·4	101	70·5°	65·5°	44°	10·5°	33·5°	76°	3·50		—	cal ad l zygomatico- and occipito-temporal and r. maxillary defective. bilateral frontal process of squamous temporal. prominent inion. slight occipital prominence
95	♂?	1506	187·5	—	190·5	141	92·5	120	110 *h*	93·5	530	375	297	124	135	116	93	57·2	—	—	—	—	—	—	—	—	—					74	63	117·5													3·67	3·13	85·3	cal f ad
96	[illegible]		172·5	[illegible]	177	[illegible]	92		[illegible]		487	352	292	[illegible]	116	115	[illegible]	60·2	68			51	27	43		33		42·5	-	72·6		72·0				52·9	76·7									82				cal ad basal occipital defect r. malar receding forehead (? microcephalic)
97	♀?	1582	194	194	194	143·5	103	132	116	96	539	401	307	133	126	142	115	57·8	63	89	121	46	22·5	41	41	32·5	32	44	36·5	74	68	74	68	108·7	70·8	48·9	70·3	78	82·9	92	67°	74°	39°	13°	26°	87°	3·33	2·68	80·5	cal. metopic. suture and ridge parietal bulging and rather pear-shaped in *norma verticalis*. occipital prominent. See Plate XI
98	♀	1334	183	184	185	137·5	96	130	110	100	511	365	301?	126	123	116	100·5	64·5	66	—	—	49·5	21·5	-	39	-	31·5	44·5	32·5	74·7	70·6	74·3	70·3	105·8		43·4		80·8	73	94	65·5°	75°	39·5°	11°	28·5°	86°	3·40	2·67	78·5	cal. ad r temporal and zygomatic l malar defects slight post coronal depression. ossicles in lambdoid (one on l. 15 × 16 mm.) and r parieto-mastoid suture. flattening of obelion. faint *torus occipitalis*

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* Not taken into account, except for angles.

RANIA.

Indices			
B/L	H/L	B/H	G′H/G
6·7	69·4	110·5	76·1
4·9	66·5	112·7	—
0·8	67·9	104·3	—
7·1	68·6	112·3	—
5·8	66·7	113·6	—
9·2	66·8	118·6	—
—	—	—	—
7·7	65·6	118·5	—
9	70·5	112	71·3
3·4	66·3	110·7	—
4·5	65·8	113·2	73·2
—	—	—	—
75·6	—	—	—
—	—	113·2	—
75·7	66·3	114·1	69·1
—	—	110	—
72·7	67·6	107·6	—
71·6	70·4	101·8	—
73·5	66·1	111·1	69·
75·3	—	—	—
79·6	—	—	—
73·7	60·5	121·8	—
76·4	70·3	108·6	75·

MEASUREMENTS OF MOORFIELDS CRANIA.

TABLE IV.

Series No.	Sex	C	Lengths								Circumferences								Face									Palate		Indices										GI	Angles						Foramen			Remarks
			F	l	L	B	B'	H	OH	LB	U	S	Q		S_1	S_2	S_3	C	G'H	GB	J	NH	NB	O_1 L	O_1 R	O_2 L	O_2 R	G_1	G_2	b,I	H,I	B I	H I	B H	G'H, GB	NB NH	O_2/O_1 L	O_2/O_1 R	$G_2\ G_1$		N∠	A∠	B∠	θ_2	θ_1	P∠	fml	fmb	fmb/fml	
99			192·5		193	148	97	134	119 h	[illegible]	544	401	—	137	—	—	—	—	68·5	90	—	49	20·5	42·5	43	32·5	32·5	46	—	—	—	76·7	69·4	110·5	76·1	41·8	76·5	75·6	—	93	66·5°	71°	42·5°	—	—	—	3·42	2·65	77·5	cal. ad. r. temporal absent. coronal ridge. marked bathrocephaly. ossicle of λ with series of large ossicles in lambdoid suture. See Plate XVII
100	[illegible]	1212 ?	178·5	177	177·5	133	92	118	98·5	90	498	346	268	121	118 ?	107 ?	87 ?	58·1	68	—	—	50·5	22	—	40	—	35	—	—	75·1	66·7	74·9	66·5	112·7	—	43·6	—	87·5	—	81	60°	73·5°	46·5°	13°	33·5°	86·5°	3·81	3·21	84·2	cal. ad. l. malar defective. posterior sagittal groove. pair of minute precondylar eminences
101	[illegible]	1445 ?	186		190	134·5	94·5	129	113 h	96	517	376		1[illegible]	128	116	100	63·8	67·5			50	20	42		35		50				70·8	67·9	104·3		52	90·5			97	70·5	68·5	41				3·87	3·22	83·2	cal. ad. l. temporal and r. malar defective. slightly grooved obelion. prominent occiput. traces of ossicle of pterion. See Plate XIV
102	[illegible]	1526	184	187	188	145	96·5	129	108	99	528	375	300	1[illegible]	126	117	91	55·8									—			77·5	69	77·1	68·6	112·3						—	—					—	3·15	3·00	95·2	cal. f. ad. with l. malar bone. post coronal depression. slight mid. sagittal groove. slight bathrocephaly. no wormians
103	♂	1709	194	—	198	150	104	132	117·5 h	98·5	548	395	314	13[illegible]	132	131	104	56·6	—	—	—	—	—	—	—	—	—	—	—	—	—	75·8	66·7	113·6	—	—	—	—	—	—	—	—	—	—	—	—	3·88	3·02	77·8	cal.–f. ad. metopic. post coronal depression. slight bathrocephaly. two ossicles in outer part of lambdoid r. side. prominent inion
104	♀		183	—	185·5	147	98	124	111 h	90	522	365	303	11[illegible]	113	133	104·5	56·1	—										—			79·2	66·8	118·6													3·70	3·15	83·1	cal. f. ad. r. temporal and l. spheno-ethmoidal defects. ossicle of l. lambdoid. linguiform process of occipital
105	♀	—	190	—	—	134	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	dome. ad. protuberant occipital. ossicle of λ
106	♀	146[illegible]	184		186	141·5	95	122	119·5 h	90	522	371	29[illegible]	1[illegible]5	127	119	94	56·4														77·7	65·6	118·5													3·40	2·94	85	cal. f. ad. faint posterior sagittal groove. slight *torus occipitalis*
107		1491	18[illegible]	182·5	183	144·5	95	12[illegible]	11[illegible]	97	51[illegible]	365	30[illegible]	1[illegible]	123	121	100·5	50·7	64·5	[illegible]·5		51·5	25	43	44	31	32	46	35	79·2	70·7	79	7[illegible]·5	112	71·3	48·5	72·1	72·7	70·1	95	[illegible]	72	[illegible]	7	32	7[illegible]	3·53	3·01	85·3	cal. ad. l. zygomatic defect. slight coronal ridge. bilateral fronto-temporal junction. protuberant occipital
108	[illegible]	12[illegible]	183·5		182·5	134	[illegible]·5	12[illegible]	108 h	93·5	510	374	28[illegible]	1[illegible]8	127	119	98	56·9														73·4	66·3	110·7	—												3·35	3·01	8[illegible]·8	cal. f. [illegible] ad. ethmo-sphenoidal defect. prominent inion. slight post coronal flattening
109	[illegible]	1339	181	183	184	137	92	121	104·5	96	508	358	287	123	?	?	?	—	65·5	89·5	124	52	24	42·5	42·5	33	33·5	47	40·5	74·9	66·1	74·5	65·8	113·2	73·2	46·1	77·6	78·8	86·2	95·5	69·5	70·5°	40				3·38	2·91	86·1	cal. old. plagiocephalic. l. occipital flattening. slightly depressed obelion. (? fronto-temporal junction)
110	♂	—	—	—	—	146·5	108	—	116 h	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	dome. ad. defective. metopic
111	♂	—	189·5	—	188·5	142·5	106	—	116 h	—	537	—	—	131	124	—	—	—	69	?	—	51	24	41·5	42·5	30	31·5	51·5	—	—	—	75·6	—	—	—	47·1	72·3	74·1	—	—	—	—	—	—	—	—	—	—	—	cal. ad. large occipital and l. temporal defect. metopic. *torus occipitalis*. ossicles in lambdoid. faint post coronal depression
112	[illegible]					132·5		117	1[illegible] h	—	—	—	275	—	110	109	92	61·2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	113·2	—	—	—	—	—	—	—	—	—	—	—	—	3·68	2·92	79·3	hinder part of cranium. ad. facet on anterior margin of *foramen magnum*
113	[illegible]	13[illegible]	182	18[illegible]·5	181	137	89	120	107	99	513	353	290	120	126	98	84	63·0	60·5	87·5	124	46·5	22·5	39	38	31·5	30	44	37	75·0	66·5	75·7	66·3	114·1	60·1	48·4	80·8	78·0	84·1	95	68°	75·5°	36·5°	11·5°	25°	87°	3·54	3·14	88·7	cal. [illegible] ad. 3rd molar in plane. infantile upper face. post coronal depression. ossicles of λ (between parietals) 13 × 13 mm. obelion slightly depressed
114	♀	—	—	—	—	143	—	130	114 h	—	—	—	302	—	134	122	101·5	59·9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	110	—	—	—	—	—	—	—	—	—	—	—	—	3·49	2·95	84·5	cal.–f. ad. large frontal defect. protuberant occipital. slight *torus occipitalis*. faint post coronal depression
115	♀	1293?	183	—	185	134·5	94	125	110 h	93·5	510	360	287	120	?	?	?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	72·7	67·6	107·6	—	—	—	—	—	—	—	—	—	—	—	—	3·15	2·33	74	cal.–f. ad. with ethmoidal defect. faint *torus occipitalis*. flattening of obelion
116	♂	—	192	—	194	130	101·5	136·5	117 h	101·5	540	385	—	131	134	120	100·5	60·5				—										71·6	70·4	101·8					—		—						4·01	2·88	71·8	cal. f. ad. large l. temporo-sphenoidal defect. metopic
117	[illegible]	1283	182	182·5	18[illegible]	131·5	92·5	121	107	103	508	3[illegible]	2[illegible]	1[illegible]	124	114	92·5	57·9	64	62	120	40	25	42·5	41·5	2[illegible]·5	29·5	51	42·5	73·7	66·[illegible]	73·5	66·1	111·1	60·6	54·3	69·4	71·1	83·3	98	67	76	37	8	2[illegible]	84	3·08	2·55	82·8	cal. ad. (? young) small r. frontal defect. post coronal depression. parietal expansion. slight r. parieto-occipital flattening. bilateral pterygo-spinous bridge
118	♀	—	185·5	—	186	140	97·5	—	111 h	—	510	375	—	133?	111	135	103·5	55·1	—	—	—	—	—	—		—		—				75·3							—								3·31	3·[illegible]	90·9	dome. ad. large frontal defect. depression of obelion. median parietal foramen. linguiform process to occipital 25 × 41 mm.
119	♀	—	173·5	—	174	138·5	91	—	—	—	493	351	—	110	110	113	91·5	57·8	—	—	—	—	—	—	—	—			—			70·6							—							—			—	dome. ad. l. upper parietal defect [See Plate XII
120	[illegible]	1425	18[illegible]	1[illegible]8	1[illegible]	14[illegible]	95·5	115	1[illegible]	[illegible]	525	3[illegible]	299	1[illegible]	115	118	97	58·6	72·5			54·5	25	44		37	30·5	44·5	41·5	73·7	60·5	73·7	60·5	121·8		40·2	84·1		93·3	91	65·5	68·5	40	11	35	79·5	3·82	2·84	74·3	ad. r. malar defect. post coronal depression. receding forehead
121	[illegible]		181·5		182	136	98	128	11[illegible]	93	518	37[illegible]	300	1[illegible]	132	110	94?	62·6	62	82	110·5	47	24·5	45	45	32·5	32	47·5	37			76·4	70·3	108·6	75·6	52·1	72·2	71·1	77·9	95	72·5	69	38·5				3·22	3·14	97·5	ad. (? old) l. temporo-parietal defect. slight bathrocephaly. sagittal and lambdoid sutures obliterated

ON THE RELATIONSHIP OF INTELLIGENCE TO SIZE AND SHAPE OF HEAD, AND TO OTHER PHYSICAL AND MENTAL CHARACTERS.

BY KARL PEARSON, F.R.S.

(1) *Introductory.* In two earlier memoirs* my co-workers and I have dealt with certain of the present problems. The methods then used by us were such as are suitable for dealing fairly rapidly with large masses of material, and by those methods the conclusions drawn were:

(*a*) that there is a slight correlation between size of head and general intelligence†,

(*b*) that this correlation is not sensibly increased by allowing for the size of the body relative to the size of the head‡,

(*c*) that the correlation is so small that it would be absolutely idle to endeavour to predict the intellectual ability of an individual from his or her head measurements§. On the other hand, if a population were divided into those with large and those with small heads, we should expect to find a very slight balance of average intelligence in the former group.

The present more precise and extended investigation is based upon the more elaborate statistical reductions carried out during the last few years in my Biometric Laboratory.

The material dealt with is the same, namely:

(i) The head measurements of upwards of 1000 Cambridge graduates. I have already expressed my thanks to the Cambridge Anthropometrical Committee for this material, and to Mr W. H. Macaulay of King's College, and the University Registrary for supplementing the measurements with ample particulars of the examinational standing of each graduate.

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* *R. S. Proc.* Vol. 69, pp. 333—342, 1902; *R. S. Proc.* Vol. 71, pp. 106—114, 1902.

† *R. S. Proc.* Vol. 69, p. 339.

‡ *R. S. Proc.* Vol. 71, p. 112.

§ *R. S. Proc.* Vol. 69, p. 340. See also a series of letters to the *British Medical Journal*, Jan. 27—March 17, 1906, and *Biometrika*, Vol. III. p. 391 *et seq.*

(ii) The measurement and observation of considerably more than 5000 school children. This material was collected by the aid of many teachers, and with assistance from the Government Grant Committee*.

The present investigation deals with the girls as well as the boys, who alone were considered in the earlier papers. Further, it gives the results in as complete a form as they admit of being tabulated in, and reduces them therefore by a more ample theory than was previously possible. We have investigated the mean and variability of each grade of intelligence for each measurable character. From these means we have deduced the fundamental constant, the correlation ratio η, which becomes identical with the coefficient of correlation when the regression is linear†. The value of η must of course depend to some extent on the nature of the intellectual grading, but the results now obtained are: (i) in good agreement with those of the preliminary papers deduced by a totally different statistical process, (ii) in good accordance with each other.

While they largely extend, they yet in every respect confirm our previous main conclusion that: While there exists a slight but sensible relation between size of head and intelligence, there is no possibility of using this relation to make even rough individual predictions.

In the present memoir the full results are for the first time published, and there will be found some discussion of each character taken in order.

(2) *On the Expression of Intelligence by a Quantitative Scale.*

In dealing with the Cambridge graduates we classified our material into four grades only: (i) *First Class Honours,* (ii) *Second Class Honours,* (iii) *Third Class Honours,* and (iv) *Pass Degrees.*

In the case of the school data we classified into (i) *Quick Intelligent,* (ii) *Intelligent,* (iii) *Slow Intelligent,* (iv) *Slow,* (v) *Slow Dull,* (vi) *Very Dull.*

Now, for the purposes of determining the correlation ratio between intelligence and the physical characters, it is unnecessary to make any assumption as to the extent to which these grades fit into any quantitative scale. But in order to exhibit the results graphically, it is needful to have some scale of intelligence to plot our average physical characters to. We have accordingly selected, as the normal scale of intelligence, that which would be given if the frequency distribution of intelligence followed the normal or Gaussian curve of errors. Whatever the true scale may be, it can only be a more or less—probably less—distorted form of this scale. Such horizontal distortion has no effect on the value of the correlation ratio for the plotted physical character, and an *a priori* justification of

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[*] Fuller particulars as to the schedules and method of collecting will be found in my Huxley Memorial Lecture: see *Biometrika,* Vol. III. pp. 131—190.

[†] "Mathematical Contributions to the Theory of Evolution, XIII, On the Theory of Contingency and its Relation to Association and Normal Correlation." *Drapers' Company Research Memoirs,* Dulau and Co.

the scale may be found in the fact that the plotted points of the regression curves are for a number of pairs of characters, within the limits of random sampling, on a straight line when such a scale of intelligence is used. It is convenient to put the plotted values of the physical character in each case along the centroid value of the frequency of the corresponding grade.

In the Cambridge graduates the median ability lies fairly closely on the boundary between third class honours and pass degrees. In the school children the median division is closely in girls, and less closely but still approximately in boys, between the intelligent and slow intelligent groups. The following, indeed, will be found to give roughly the equivalent grading:

School Children		*Graduates*
Quick Intelligent	=	First Class Honours.
Intelligent ...	=	Second Class Honours. Third Class Honours.
Slow Intelligent	=	Pass Degrees.
Slow		
Slow Dull ...		
Very Dull ...		

This equivalence of grouping is a fairly satisfactory result, but it suggests that, in future, it would be better to break up the intelligent class into two sub-groups, and to differentiate further those who take pass degrees. We might then form the following scale of intelligence:

(α) Specially Able, (β) Capable, (γ) Intelligent, (δ) Slow Intelligent, (ϵ) Slow, (ζ) Slow Dull, (η) Very Dull and Mentally Defective. The first three groups would then correspond approximately to first, second, and third class school and University honours*.

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* To the teacher trained by many generations of pupils these divisions will provide almost unconsciously an appreciation of classes. For those who have not this experience it is difficult but necessary to attempt a verbal description. The following definitions are based on those provided in the schedules for the inquiry as to school children, and for a further research on adults in progress.

(α) *Specially Able:* a mind especially bright and quick both in perception and reasoning about not only customary but novel facts. Able and accustomed to reason rightly about things on pure self-initiative.

(β) *Capable:* a mind less likely than the specially able to originate inquiry, but quick in perception and in reasoning rightly about the perceived.

(γ) *Intelligent:* a mind ready to grasp and capable of perceiving facts in most fields. Capable of good reasoning with a moderate effort.

(δ) *Slow Intelligent:* a mind slow generally, although possibly more rapid in certain fields, but quite sure of knowledge once acquired.

(ϵ) *Slow:* a mind advancing in general, but very slowly; with time and considerable effort not incapable of progress.

(ζ) *Slow Dull:* a mind capable of perceiving relationship between facts in some few fields with long and continuous effort, but not generally, or without external aid.

(η) *Very Dull:* a mind capable of holding only the simplest facts, and incapable of grasping or reasoning about the relationship between facts; the very dull group covers but extends somewhat further up than the mentally defective.

If we pass to the quantitative measurement of these groups, we may compare them either (i) by equivalence of variability, or (ii) by equivalence of class.

These two methods of approaching the matter are indicated in Tables I and II.

If we take σ_i the standard deviation of intelligence as unit, we obtain the three scales given in Table I, and we see that the scale differs somewhat for girls, boys, and men.

TABLE I.

Relative Scales of Intelligence with the Standard Deviation σ_i as Unit.

Class	School Girls	School Boys	Graduates	Class
Median Individual downwards	$\cdot007\sigma_i$ below top of Slow Intelligent Group	$\cdot113\sigma_i$ below top of Slow Intelligent Group	$\cdot046\sigma_i$ above bottom of 3rd Class	Median Individual downwards
Median Individual upwards	$\cdot853\sigma_i$ above bottom of Slow Intelligent Group	$\cdot733\sigma_i$ above bottom of Slow Intelligent Group	$\cdot436\sigma_i$ below top of 3rd Class	Median Individual upwards
Range of Slow Intelligent	$\cdot860\sigma_i$	$\cdot846\sigma_i$	From $\cdot046\sigma_i$ below median to ∞	Range of Pass Degrees
Range of Slow	$\cdot642\sigma_i$	$\cdot722\sigma_i$		
Range of Slow Dull	$\cdot640\sigma_i$	$\cdot725\sigma_i$		
Range of Very Dull	From $2\cdot135\sigma_i$ below median to ∞	From $2\cdot180\sigma_i$ below median to ∞		
Range of Intelligent	$1\cdot033\sigma_i$	$1\cdot108\sigma_i$	$1\cdot077\sigma_i \begin{cases}\cdot482\sigma_i \\ \cdot595\sigma_i\end{cases}$	Range of 3rd Class Range of 2nd Class
Range of Quick Intelligent	From $1\cdot040\sigma_i$ above median to ∞	From $1\cdot221\sigma_i$ above median to ∞	From $1\cdot031\sigma_i$ above median to ∞	Range of 1st Class

The divergence, however, is probably not wholly due to a difference of variability. The bulk of the girls were observed by women-teachers, and of the boys by men-teachers, while the estimate of the graduates was formed in a wholly different manner, namely, by examination tests. Apart from this, women and men are not equally variable in any actually measurable character, and there is no reason to suppose they are necessarily so in intelligence. I have therefore rearranged the scales on the assumption that our common unit is the "Intelligent" group, and that this is the same for boys and girls and equal to the range of the third and second classes of graduates. Table II exhibits this result, and Fig. 1 gives the corresponding scales.

TABLE II.

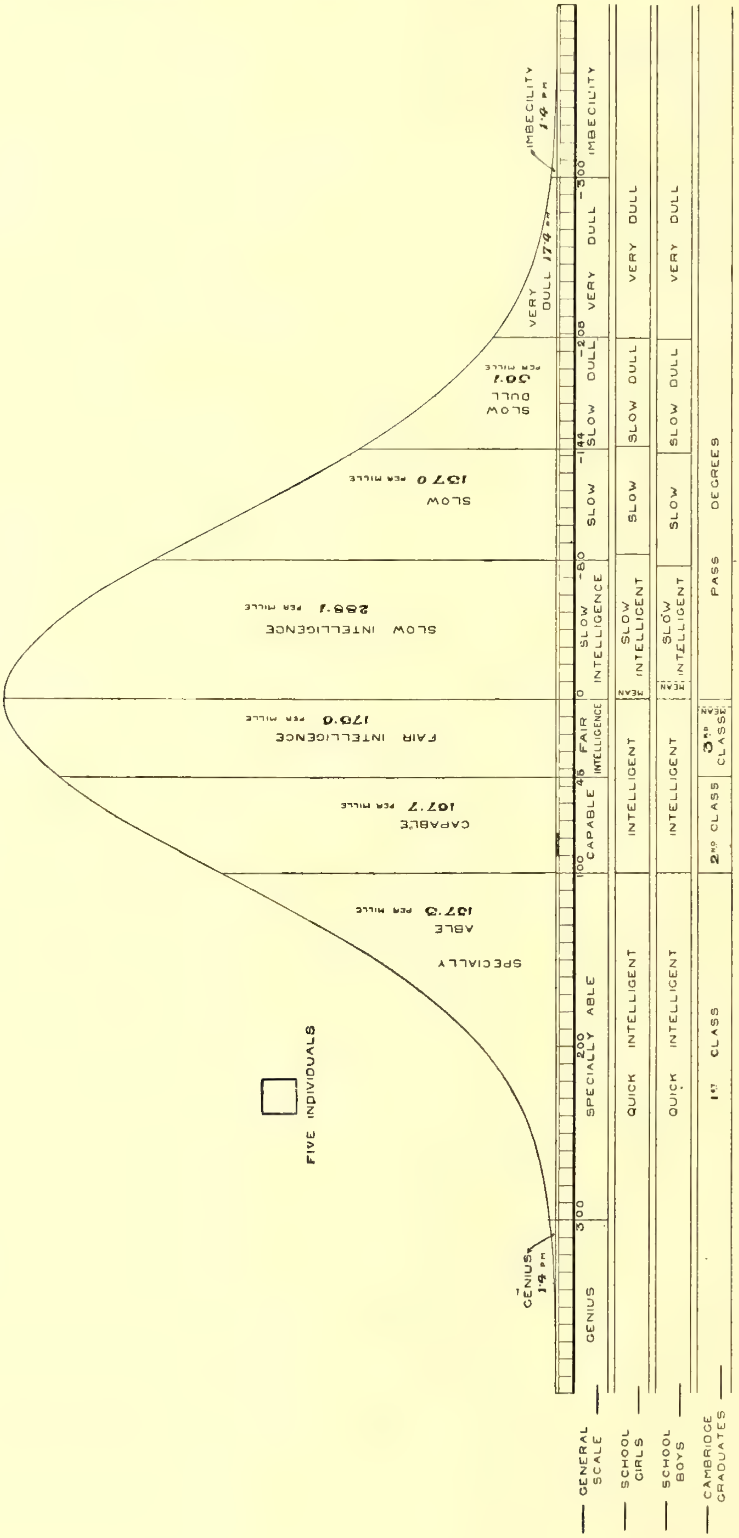
Relative Scales of Intelligence with the range of "Intelligent" taken as Unity.

Class	School Girls	School Boys	Graduates	Class
Median Individual downwards	·007 below top of Slow Intelligent Group	·102 below top of Slow Intelligent Group	·043 above bottom of 3rd Class	Median Individual downwards
Median Individual upwards	·826 above bottom of Slow Intelligent Group	·662 above bottom of Slow Intelligent Group	·405 below top of 3rd Class	Median Individual upwards
Range of Slow Intelligent	·833	·764	From ·043 from median to ∞	Range of Pass Degrees
Range of Slow	·622	·652		
Range of Slow Dull	·620	·654		
Range of Very Dull	From 2·066 below median to ∞	From 1·967 below median to ∞		
Range of Intelligent	1·000	1·000	$1{\cdot}000\left\{\begin{matrix}{\cdot}448\\{\cdot}552\end{matrix}\right.$	Range of 3rd Class Range of 2nd Class
Range of Quick Intelligent	From 1·007 above median to ∞	From 1·102 above median to ∞	From ·957 above median to ∞	Range of 1st Class

Thus, as we might have anticipated, to suppose the intelligent to give unit range on the intellectual standard provides us with far more concordant results than estimating the variability to be the same for boys, girls, and graduates. In fact, an examination of Fig. 1 shows for this sort of enquiry surprisingly close results. It is clear that the median character is very close to the frontier between slow intelligence and intelligence, or between honours and pass in the Cambridge academic standard. There is clearly a little shifting of the boundaries of the "dull group" between boys and girls, but the mean values of the limits may well be taken as within the limits of the probable error.

After much consideration, I would tentatively suggest the following scale of intelligence:

I divide the range of the "Intelligent" into a hundred units, which I propose to term *mentaces*. It is clear that we can have no absolute measure of the intelli-



Proposed Scale of Intelligence, based on the examination of 4658 children and 1011 University graduates

Fig. 1. The scale immediately under the normal curve is the scale of mentaces.

gence of the median individual*, hence intellectual grades will be measured by a plus or minus number of mentaces above the median. The median individual must be looked upon as one whom, if a child, an experienced teacher would hesitate to class in the intelligent or slow intelligent groups, or who would be considered a doubtful honours candidate at Cambridge. Clearly 100 mentaces is not far from the standard deviation of intellectual power in man†.

The following is the suggested classification:

(i) *Genius*‡, more than + 300 mentaces. This corresponds to individuals of more than three times the standard deviation from the mean.

(ii) *Specially Able*, + 100 to + 300 mentaces. This corresponds to quick intelligent children and first class University honours.

(iii) *Capable*, + 45 to + 100 mentaces. This corresponds to second class University honours.

(iv) *Fair Intelligence*, + 0 to + 45 mentaces. This corresponds to third class University honours. Groups (iii) and (iv) cover the ground occupied by the school teacher's classification of "intelligent," and comprise about one-third of the total population.

(v) *Slow Intelligent*, – 0 to – 80 mentaces.

(vi) *Slow*, – 80 to – 144 mentaces.

(vii) *Slow Dull*, – 144 to – 208 mentaces.

(viii) *Very Dull*, – 208 to – 300 mentaces. This group passes into the mentally defective. Groups (v) to (viii) occupy the range corresponding to pass men from the academic standpoint.

(ix) *Imbecile*, less than – 300 mentaces.

We may look upon the whole scheme from another standpoint, corresponding more closely to Francis Galton's decile arrangement, though unfortunately we can only *a posteriori* determine our class indices, and cannot make them suitable round numbers.

Taking 1000 individuals and arranging them in intellectual order: The first, one man in a thousand, would be a genius, then follow 157 specially able men, next 168 capable men, then 174 of fair intelligence; this covers the 50 per cent. above the average. Below the average we have first 288 of the slow intelligent type, then 137 slow persons, next 56 slow dull, followed by 18 very dull including mentally defective individuals, and finishing with one imbecile; thus completing the 50 per cent. with less than average intelligence.

This scale is represented in the upper part of Fig. 1.

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* He can hardly have more than 350 to 400 mentaces, for at a negative position of – 350 to – 400 on the scale we have passed through the very dull group into imbecility and complete absence of reasoning power. The child whose low grade of intelligence occurs only 3 or 4 times in 100,000 cases, must be sought in the idiot asylum.

† The standard deviation of school girls is 96·8 mentaces, of school boys 90·3, and of graduate males 92·9, or an average of 93·3 mentaces. The females thus appear more variable than the males in intelligence.

‡ This is of course, purely arbitrary, the simple quantitative idea of "one man in a thousand."

Naturally I do not insist on any particular part of this scale. The numbers are entirely round numbers, and are based on the "normal" distribution of the frequency of intelligence. Still, it is deduced from three series covering the classification of between 4000 and 5000 cases, and the three separate results are in general accord. It will, I think, be possibly useful for other enquirers, and it endeavours to give quantitative expression to our verbal definitions of the intellectual categories. One or two points are suggestive. While the specially able men, the first class in academic judgment, are fewer than either the capable men or the fairly intelligent men, they cover a range double the extent of that of both these two classes added together. In other words, the differences among the specially able are far more marked than in the case of "intelligent" men. This is of course a universal experience, but it is of interest to see its approximate quantitative value.

In the same way the Very Dull minds, although only one-third as numerous as the Slow Dull, and hardly more than one-eighth of the Slow minds, yet occupy a range 50 per cent. greater than that of either of these groups. Thus we see again the source of the great differences in mental stupidity. The apparent want of continuity in the ranges of genius or of imbecility, which must arise when few individuals are spread over a large range, thus enables us to comprehend how it is possible to look upon these things as anomalies and mutations*.

(3) *On the Relation of Intelligence to Age.*

On the hypothesis that intelligence is very sensibly correlated with either brain-weight or head-size, we might not unnaturally anticipate that growth, which modifies largely the physical characters, would influence the intellectual†. It seemed of importance accordingly to enter very fully into the relationship of age to intelligence. Unfortunately the material provided by the Cambridge graduates does not lend itself to an age investigation. It is true that we have the ages provided, but the material consists in great bulk of young men measured in their 19th or 20th years. A certain number of resident "dons" are available in the Cambridge Anthropometric Committee's material, but this group of older men is a stringently selected group, only the men of considerable intellectual achievement from the academic standpoint remaining in residence. Neither in the Cambridge data nor elsewhere did it seem possible to find the material requisite to settle the problem of the relationship of intelligence to age in adults. We are forced, therefore, to confine our attention to the influence of age on general intelligence in childhood.

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* For the actual quantitative treatment of this form of discontinuity, see *Biometrika*, Vol. I. pp. 385—399.

† When is the intellectual 'prime' in man? His prime in stature is about 27; his prime in head measurements probably two or three years earlier; his prime in brainweight in the teens and probably early in the teens. We know how many inches of stature, how many mm. in head diameters and how many grs. in brainweight he loses yearly after his physical primes. How many mentaces does he lose each year after his intellectual prime? We have no knowledge at present. Yet these very sensible changes which follow physically after the different primes are of the same magnitude as those differences between individuals upon which relations between intelligence and physique are based; they are, however, tacitly put on one side by writers on this subject.

Table III gives the age and intelligence grade for schoolboys; Table IV the same characters for girls.

TABLE III.

Age and Intelligence. Boys.

Age	Quick Intelligent	Intelligent	Slow Intelligent	Slow	Slow Dull	Very Dull	Totals
4	1	2	1	2	—	—	6
5	2	5	5	4	1	—	17
6	6	12	15	4	3	—	40
7	19	25	25	4	6	4	83
8	20	60	39	30	7	—	156
9	24	57	60	34·5	7·5	6	189
10	33	76·5	72·5	35	21	2	240
11	35	96·5	105	42·5	11	5	295
12	39	110	120·5	51	12·5	3	336
13	27	107·5	108·5	57·5	25·5	11	337
14	29	84	70	39·5	16	3·5	242
15	16	66·5	68·5	19	16	2	188
16	14	39	43	28	9	2	135
17	9	24	24	8	4	3	72
18	3	16·5	11·5	8	—	—	39
19	2·5	5·5	2	2	—	—	12
20	—	1	1	—	—	—	2
Totals	279·5	788	771·5	369	139·5	41·5	2389

TABLE IV.

Age and Intelligence. Girls.

Age	Quick Intelligent	Intelligent	Slow Intelligent	Slow	Slow Dull	Very Dull	Totals
3	—	1	—	—	—	—	1
4	1	5	—	—	—	—	6
5	4	5	9	1	—	—	19
6	7	13	14	4	3	—	41
7	16	27	20	6	6	2	77
8	20	40	33	15	4	2	114
9	20	74	61	22	7	2	186
10	27	91	69	23	9	3	222
11	38	106·5	90·5	23	10	4	272
12	44	106·5	84·5	36	18	5	294
13	38	93	80	40	10	3	264
14	32·5	64	60	29·5	13	4	203
15	22	64·5	75	33·5	13	7	215
16	19	48	54	27	7	4	159
17	18·5	34·5	21	8	8	2	92
18	14	20·5	14·5	10	5	1	65
19	2	3	4	3	—	—	12
20	1	1	3	2	—	—	7
Totals	324	797·5	692·5	283	113	39	2249

From these Tables the following constants were calculated:

TABLE V.

Variability and Mean Ages of Mental Groups.

Group	Boys			Girls		
	Mean Age	Standard Deviation		Mean Age	Standard Deviation	
Quick Intelligent	12·01	2·964	2·867	12·67	3·214	3·059
Intelligent ...	12·48	2·872		12·45	2·978	
Slow Intelligent...	12·49	2·766		12·64	2·985	
Slow	12·46	2·833	2·784	13·17	2·970	2·975
Slow Dull ...	12·52	2·755		13·03	3·077	
Very Dull ...	12·50	2·764		13·27	2·878	
Whole Population	12·43 yrs	2·839 yrs		12·67 yrs	3·028 yrs	

Examining the means of each intelligence grade first, and taking the boys to start with, we note: That if we omit the quick intelligent group, the mean ages of each intelligence group are essentially the same. With the girls, dullness seems to increase somewhat with age. If we examine the broken vertical lines Fig. 2, we can see, I think, a differentiation between boys and girls; the duller girls have a greater average age. Now the lesser age of the Quick Intelligent boys is, I think, due to the fact that bright children are allowed to go to school rather sooner than dull. But the differentiation between boys and girls is most probably due to the fact that the elder girls, 13 to 15, are commencing a period of life when physical demands upon them introduce very often a temporary and protective intellectual inertia. In the case of boys and girls, the influence of age on the extreme grades of intelligence scarcely amounts to six months at the most; and if we consider the facts that bright children go early to school, and leave early, while dull children go late and leave late, and again that the elder girls are especially apt to feel intellectually the burden of physical development, I think we may safely assert that there is no substantial change of intelligence with age.

The actual correlation ratios are:

$$\text{for boys: } \eta = \cdot054 \pm \cdot014; \quad \text{for girls: } \eta = \cdot081 \pm \cdot014;$$

and these mark a sensible, but extremely slight, *decrease* of intelligence with age. This decrease is explicable on the grounds just referred to.

We may consider here whether intelligence or dullness is the more scattered character. Turning to the columns of standard deviations, we notice: That for both girls and boys the maximum variability falls to the group of quick intelligence. This is probably due to the fact already noted, that the group is not so homogeneous as the other groups, containing a larger proportion of very able children sent young to school.

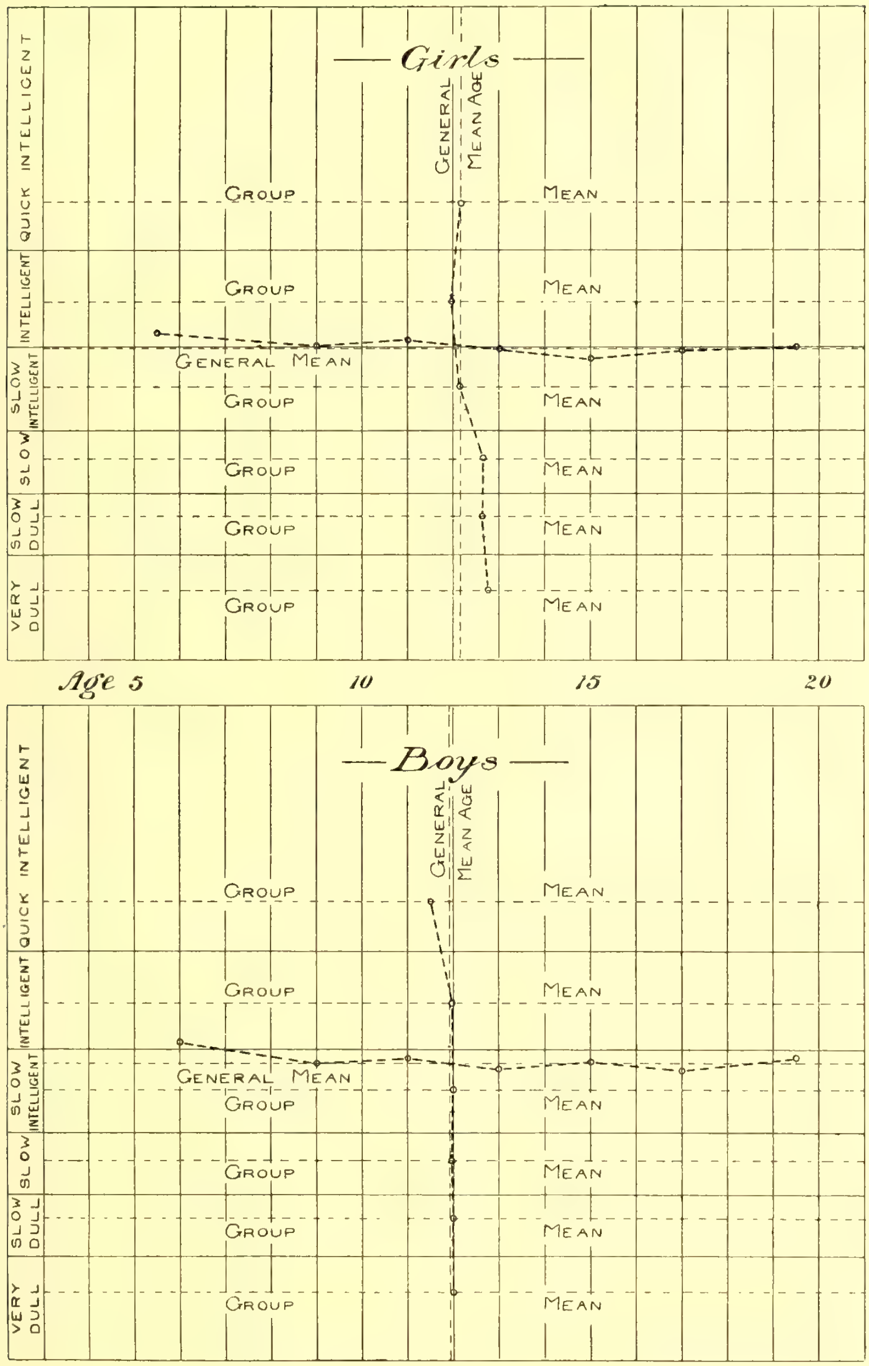
Girls
General Mean Age
Quick Intelligent
Intelligent
Slow Intelligent
Slow
Slow Dull
Very Dull
Group Mean
General Mean
Age 5
10
15
20
Boys

FIG. 2.

Taken as a whole, the intelligent group for both sexes appears to be more variable in age than the dull group; but the differences are too slight to be given much weight. If we leave out the quick intelligent group, the difference still appears, but is extremely slight*. We can only say that there possibly exists a small physical tendency for dullness to be concentrated more than intelligence on certain years of childhood.

The matter of change of intelligence with age is so important that I have approached it from another standpoint. I have enquired what is the average intelligence at each age, instead of what is the average age of each grade of intelligence. This might seem the more reasonable method of approaching the problem. But the first method, since age is quantitative, admits of direct determination of the means of the arrays; in the second method we can only find the mean intelligence of each age group by assuming the previously discussed "normal" scale of intelligence. Still the matter is of such interest that it is worth reconsidering from this standpoint. I have accordingly determined the mean intelligence of each age group. This was done as follows: The ratio in which the mean divided the groups Intelligent and Slow Intelligent taken together was determined for each array on the basis of a normal distribution of intelligence. This group covers on our scale a range of 180 mentaces. We are thus able to give the deviation from mediocrity of each age array in mentaces. This is exhibited in the following table:

TABLE VI.

Influence of Age on Intelligence in School Children.

Age Group	Boys		Girls	
	Division of Intelligent + Slow Intelligent Range into two parts in ratio	Mentaces from zero of standard scale	Division of Intelligent + Slow Intelligent Range	Mentaces from zero of standard scale
3—7	50 to 50	−10	46 to 54	+17
8—9	62 to 38	−12	54 to 46	+ 3
10—11	59 to 41	− 6	51 to 49	+ 8
12—13	65 to 35	−17	56 to 44	− 1
14—15	62 to 38	−12	61 to 39	−10
16—17	66 to 34	−19	57 to 43	− 3
18—20	59 to 41	− 6	55 to 45	+ 1
General Population	62 to 38	−12	55 to 45	+ 1

Supposing we take 350 to 400 mentaces as the full mental equipment of the average individual (see foot-note, p. 111), it will be clear that these age variations are comparatively slight. It will not, however, do to consider them solely as variations of no account due to the chance deviations of random sampling.

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* Boys: Intelligent 2·819, Dull 2·784; Girls: Intelligent 2·982, Dull 2·975.

Random sampling irregularities obscure the results, but there is a fundamental resemblance between the variations in boys and girls which does not allow of our attributing the results wholly to such irregularities. We see that both boys and girls start with greater ability in infancy; their ability then falls between the ages 8 to 9—a period possibly when teeth troubles are more marked; it rises again from 10 to 11 in both cases, but only to make a more exaggerated dip from the ages 12 to 17 during oncoming puberty. After this the tendency is to steadily rise, probably more steeply in men than in women, although the influence of oncoming puberty seems more prolonged in boys than girls. *Diagrammatically* both sexes combined give a result of the following kind, where the deviations are measured from the mean of each sex (Fig. 3).

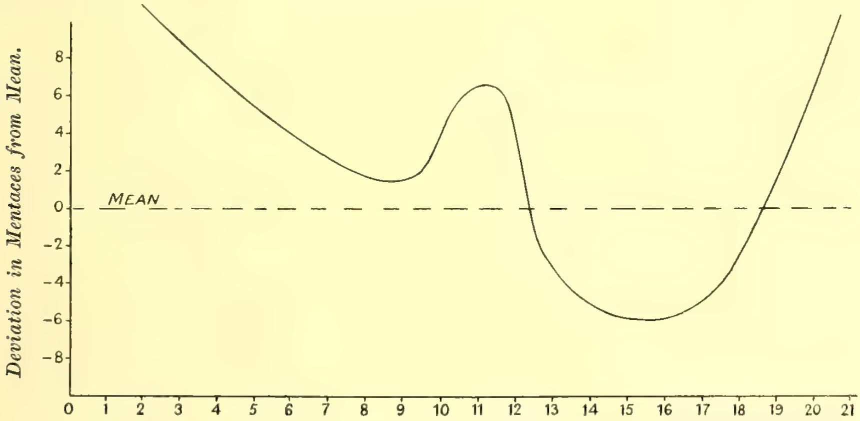

FIG. 3. Rough Diagrammatic Representation of Change of Intelligence with Age.

Now it must be noted that these variations in intelligence are very slight as compared with the total mental outfit of the average individual, perhaps 2 p.c. in boys and 4 p.c. in girls. Generally we must conclude that while there are sensible slight variations in intelligence with growth, these variations are such that they do not affect broad statements based on a consideration of the intelligence-classes of children at different ages, i.e. while the physical characters are rapidly altering and are so highly correlated with age that it is absolutely necessary to allow for this change, the mental characters are far more stationary, the changes which take place in them are by no means always in one direction, and are associated rather with growth difficulties at various stages than with a uniform development with age. Of course in any such considerations as these, we must take, as I have endeavoured to do, a scale of intelligence which is not based on a test of knowledge or training applied to children of all ages without regard to the length of their school career.

The points discussed in this section are illustrated graphically in Fig. 2. The vertical scale is one of intelligence, the horizontal one of age. The upper part of the diagram gives the results for girls, the lower for boys. The upper approximately vertical broken line shows that the duller girls are on the average slightly older; the lower approximately vertical broken line shows that age is very little dependent on the mental class in boys, when we exclude the very intelligent group. The approximately horizontal broken lines show the direct influence of age on intelligence. Their close approach to horizontality indicates how slight is the relationship; the variations are extremely small as compared with the whole mental range. But we see the parallelism of the variations in the two sexes; the general changes being shown in an exaggerated diagrammatic manner in Fig. 3.

The general results reached in this section, for example, the correlation ratios, are not dependent on the choice of a normal distribution scale, but that scale enables us to plot our results in a manner which indicates conveniently their graphical validity. A further graphical illustration is given in Fig. 4. Here

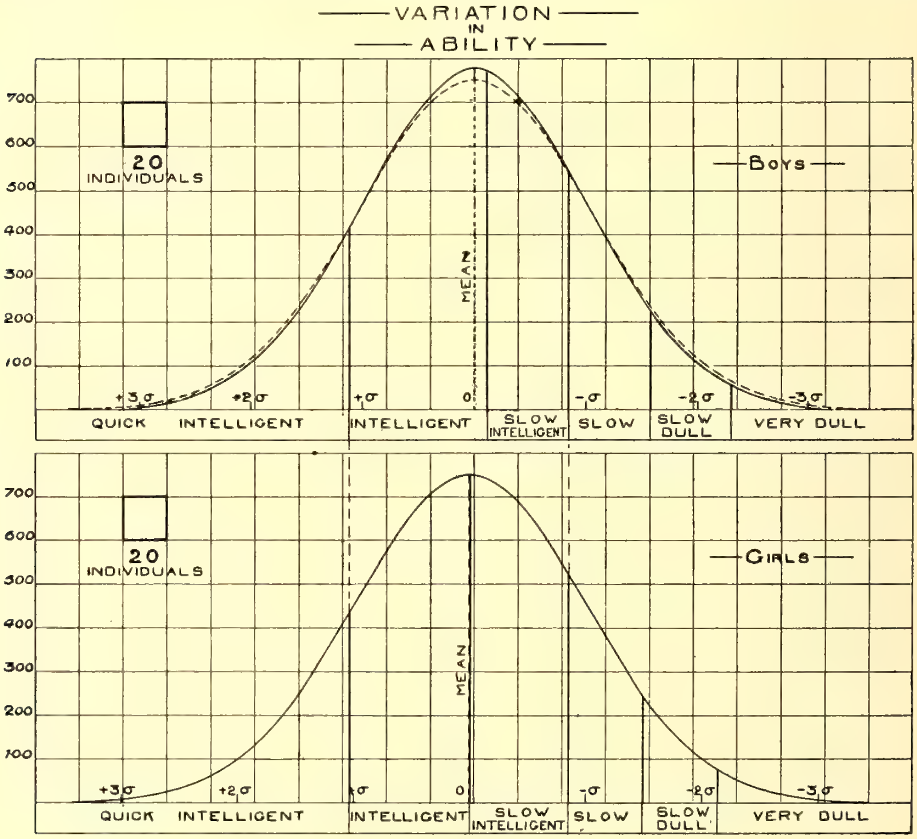

Fig. 4.

the normal curves for the school-boys' and school-girls' intelligence distributions are drawn, the total range of Intelligent + Slow Intelligent is taken as unit and the boys' and girls' distributions placed under each other on this basis. It will be seen from this standpoint that the girls' mean is slightly in excess of the boys', and if the girls' curve be now placed on top of the boys' (dotted curve of upper diagram), then it falls at the terminals slightly outside it, or very intelligent and very dull girls are more frequent than the corresponding boy classes. This greater relative variability of the girls appears confirmed by a comparison of Table V, where in each intellectual class there is more variety in the girls' than the boys' ages. To further test this, I have drawn up a table of the standard deviations in intelligence of each age group of boys and girls. These standard deviations have been calculated in terms of the Intelligent + Slow Intelligent range as the equivalent of 180 mentaces. Here again the girls appear on the whole slightly more variable.

TABLE VII.

Variation of each Age Group in Ability.

Age Group	Standard Deviation in Mentaces	
	Boys	Girls
3— 7	103	95
8— 9	99	88
10—11	94	83
12—13	90	95
14—15	89	98
16—17	97	100
18—20	84	119
Mean of 7 groups	93·7	96·9

Personally, I should lay no stress whatever on this difference, except to assert the important point, that no inequality exists between the mental variability of girls and boys. Boys are not more variable intellectually than girls. I have tried the fundamental data by all sorts of processes—not here recorded—and always with the result, that in the mass there is no sensible difference in intellectual variability between boys and girls. But the age classes do seem to indicate a difference in the distribution of this variability. While both sexes fall in variability from the earliest years of life, the girls much more than regain the lost variability by 20; on the other hand, the boys may possibly regain it—if we exclude the 18–20 group as not fairly representing boys of this age, many of whom have left school—yet they do not appear to increase rapidly beyond the infantile variability, as the girls do. The matter is deserving of a further special investigation.

(4) *On the Relation of Ability to the Size of the Head.*

Having shown that to a first approximation the grade of intelligence as estimated in the school observations is not markedly affected by age, I turn now to the relation between ability and the size of the head. In the case of the school children, all the measurements were reduced to a standard age of 12 by aid of the average growth curves. The substantial legitimacy of this process is demonstrated by the close agreement of the results with those for the Cambridge graduates. In the Appendix Tables XIV—XXIV give the tabulated measurements. These tables differ from those published in the preliminary papers, in that they no longer give mere fourfold divisions but contingency classifications showing the total distributions of head measurements for each mental grade. The method of reduction used throughout this part of the memoir was that of the correlation ratio η*.

This ratio η is a true measure of the divergence from independence of the two variables, whatever be the nature of the regression. If the regression be really linear, η passes over into the well-known correlation coefficient. The fourfold tabulation and the discovery of the correlation coefficient† were adopted in the preliminary investigations already published.

In the accompanying Table VIII the correlations between shape and size of head are given, and Fig. 5 shows the same results exhibited in a graphical form.

TABLE VIII.

Correlation Ratio between Shape and Size of Head and Ability‡.

Intelligence and	Cambridge Graduates	School boys at Twelve Years	School girls at Twelve Years
Cephalic Index ...	(1011) − ·061 ± ·021	(2345) − ·041 ± ·014	(2226) ·067 ± ·014
Length of Head ...	(1011) ·111 ± ·020	(2298) ·139 ± ·014	(2188) ·084 ± ·014
Breadth of Head ...	(1011) ·097 ± ·021	(2299) ·109 ± ·014	(2165) ·113 ± ·014
Auricular Height ...	—	(2290) ·073 ± ·014	(2166) ·055 ± ·014

Having regard to the magnitude of the probable errors, it is obvious that:

(*a*) The correlations are, with the exception of the cephalic index, in every case uniformly of one sign and sensible.

(*b*) They are so small that they are in every case of no service for the purposes of prediction.

(*c*) Within the limits of the probable error, the results for adults and for school children are in good agreement. The divergences for each character within the three populations are practically within the limits assigned by the probable error of their differences.

These conclusions are based upon a far larger number of measurements than any hitherto published, and are, I think, convincing as to the small part played by head size in determining the grade of intelligence. I have shown in another paper* that no sensible modification is made in this result if allowance be made for either weight or stature. I shall now proceed to consider the data more in detail.

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* *Drapers' Company Research Memoirs*, Biometric Series II. Dulau and Co.

† *Phil. Trans.* Vol. 195 A, pp. 1—47.

‡ The numbers in brackets give populations dealt with.

I shall first inquire what amounts of intelligence can on the average be accounted for by differences in head measurement. The average correlation between head length or head breadth and intelligence is ·11; that for auricular height is distinctly lower, and we may leave it out of consideration. The variability σ_i in intelligence for all three classes is somewhat under 100 mentaces. The variability σ in a head measurement is roundly 5 to 6 mms. Hence the regression coefficient $= r_{iH}\,\sigma_i/\sigma_H = 2$ mentaces per millimetre. Now the intellectual range from the average slow man to the average specially intelligent is (see Fig. 1) at least 200 mentaces, or we should require a difference in head measurement of at least 100 mm. to account for this intellectual difference. Now in adults there is at most *two* millimetres difference between the head measurements of the average slow and the average especially able classes. In children, for some measurements, the average difference between the Quick Intelligent and the Very Dull may amount to 5, but is more usually 2 to 4. Even if we add together the result of two or three separate measurements, supposed independent, we shall not obtain a difference of more effect than 6 to 10 mm., and this depends upon our neglecting the sensible correlation of head measurements. Thus, at a maximum, size of head might account for 12 to 20 mentaces out of the 350 which separate the mean of the specially able group from the mean of the very dull group. The millimetre which separates the head measurements of the slow boy from that of the intelligent corresponding to 2 mentaces,—or if supposed additive for several measurements, to 6 or 10 at most,—is of no effectiveness or value for purposes of prediction compared with the other causes which lead to an average difference of 120 mentaces. Differences in size of head will not account for at most $\frac{1}{12}$, and probably not as much as $\frac{1}{20}$, of the observed differences of capacity whether between adults or between children.

These results are to some extent exhibited graphically in Figs. 5 and 6. In Fig. 5 we see a drop of about 2 mm. in head length and one of about 1 mm. in head breadth in the Cambridge graduates as we pass from one end of the scale to the other. But the mean head measurement of first class honours men has for length a variability of 5·89 mm., or a quartile of about 4 mm. In other words, while 25 per cent. of able men have head lengths under 191 mm., 25 per cent. of slow men have head lengths over 197 mm. The average specially able man is 195 mm. and the average slow man 193 mm. Or again, some 44 per cent. of very able men have heads smaller than the average slow man and some 44 per cent. of slow men heads larger than the average specially able man. This order of numerical relationship holds for the whole range of the characters dealt with, and in view of it we see how idle it is to assert that head measurements can be of any service in the prediction of intelligence. In the case of Fig. 6, we see that for both boys and girls the slow increase of intelligence with size of head is quite sensible, but the variability of each group is such that some 25 per cent. of the dull have larger heads than the very intelligent, and some 25 per cent. of the very intelligent have heads smaller than the dull average. It is again impossible under such conditions to use head size as a basis for judgment as to intelligence. Of course all this is merely stating in other words what is obvious to the biometrician, when he finds a low correlation, but possibly, although I am hardly hopeful, it may help to convince the anatomist and old school anthropologist that head measurements are not of real service as intelligence tests*.

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* *R. S. Proc.* Vol. 71, pp. 106—114.

In Table IX are placed the mean and variability of each array of head measurements corresponding to different intelligence groups in the case of the Cambridge graduates. In Table X we have the same data for the school children.

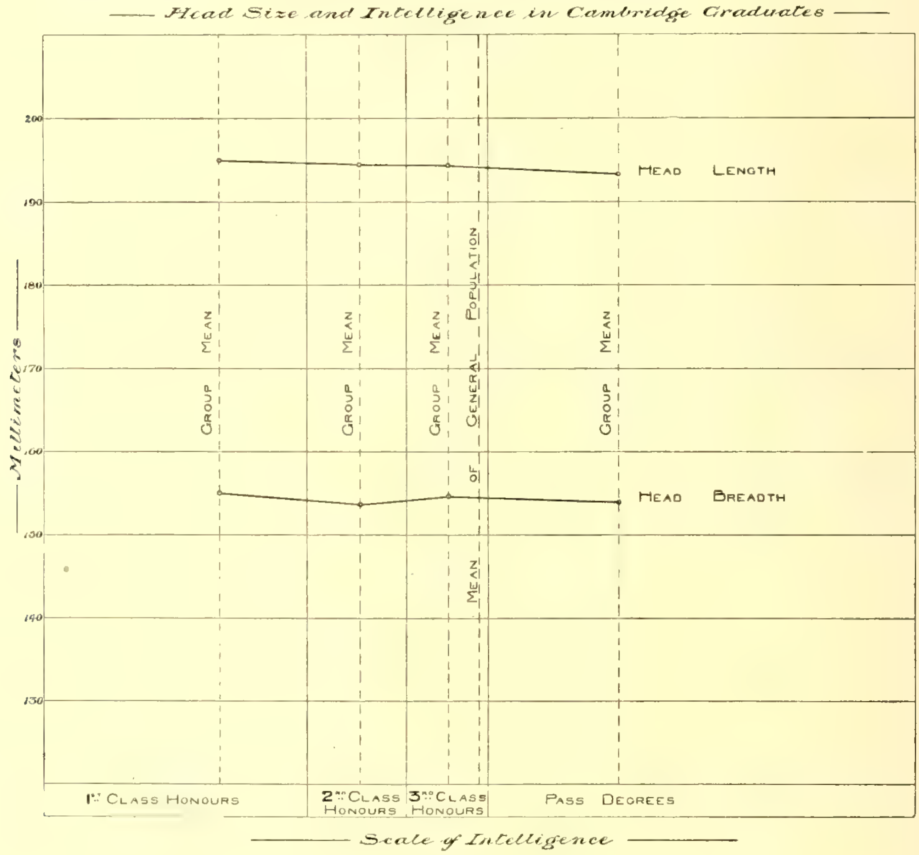

Fig. 5.

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[*] Nurture, exercise and nourishment—shortly environment and class—district or local race, influence extensively the anthropometric measurements. We cannot compare pauper imbeciles or hospital post-mortem results with middle class students or professors. We cannot measure agricultural labourers and men of science and point triumphantly to great differences in head volumes as marking widely separate intellectual grades. See the *British Medical Journal*, March 3, p. 536, and March 17, p. 651, 1906.

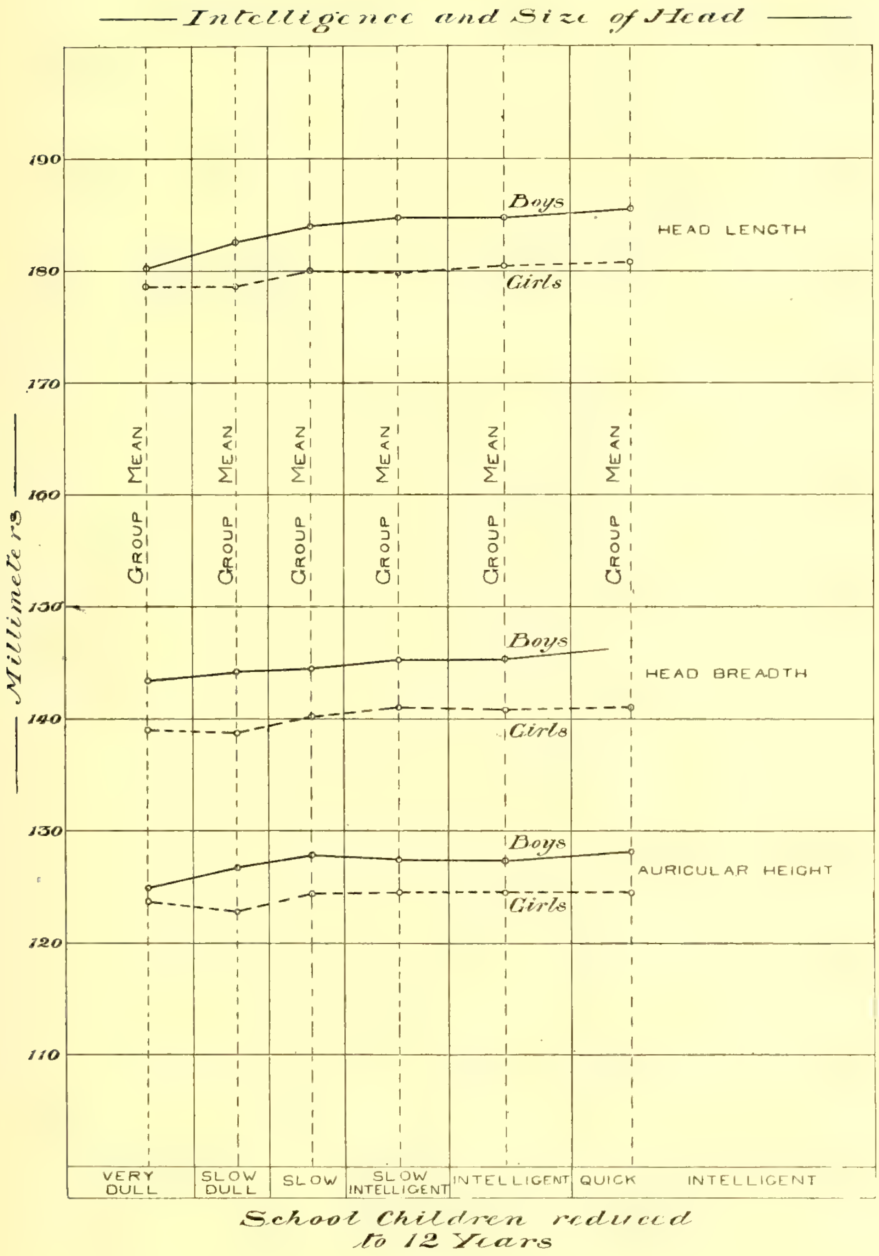
Intelligence and Size of Head
Millimeters
190
180
170
160
150
140
130
120
110
GROUP MEAN
Boys
Girls
HEAD LENGTH
HEAD BREADTH
AURICULAR HEIGHT
VERY DULL
SLOW DULL
SLOW
SLOW INTELLIGENT
INTELLIGENT
QUICK
INTELLIGENT
School Children reduced to 12 Years

FIG. 6.

TABLE IX.

Cambridge Graduates. Head Measurements.

Grade of Ability	Head Length		Head Breadth		Cephalic Index	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Honours, 1st Class	195·07	5·890	155·07	4·690	79·57	2·995
,, 2nd Class	194·51	6·026	153·73	4·708	79·22	3·129
,, 3rd Class	194·38	6·214	154·66	5·247	79·62	3·019
Poll Men	193·33	6·113	153·95	4·845	79·71	2·827
General Population	194·00	6·121	154·21	4·899	79·58	2·954

The measurements are in mm.

TABLE X.

School Children. Head Measurements at Twelve.

Grade of Ability	Head Length		Head Breadth		Auricular Height		Cephalic Index	
Boys	Mean	S. D.	Mean	S. D.	Mean	S. D.	Mean	S. D.
Quick Intelligent ...	185·45	6·237	146·40	5·822	128·11	6·418	78·96	3·201
Intelligent	184·70	6·288	145·39	5·814	127·30	6·786	78·92	3·360
Slow Intelligent ...	184·67	6·279	145·31	5·329	127·44	6·519	78·83	3·125
Slow	183·93	6·804	144·45	5·835	127·76	6·619	78·68	3·087
Slow Dull	182·25	7·463	144·23	5·810	126·66	6·467	79·12	3·325
Very Dull	180·19	7·048	143·36	6·023	124·84	6·924	79·48	3·145
General Population	184·44	6·514	145·23	5·700	127·43	6·630	78·88	3·222
Girls								
Quick Intelligent ...	180·83	5·988	140·97	6·069	124·44	6·800	78·50	3·754
Intelligent	180·35	6·202	140·86	6·337	124·54	6·505	78·43	3·927
Slow Intelligent ...	179·89	6·305	140·85	6·621	124·52	6·777	78·57	3·861
Slow	179·87	6·517	140·19	6·140	124·40	6·847	78·46	3·800
Slow Dull ...	178·61	5·962	138·72	6·802	122·86	6·177	77·74	3·871
Very Dull	178·57	6·976	136·55	9·173	123·69	7·232	76·96	4·597
General Population	180·14	6·260	140·58	6·505	124·40	6·699	78·43	3·885

It is very difficult to draw any definite and safe conclusions from the very irregular distribution of variability. Taking first the Cambridge graduates, we see that the probable error of the standard deviation is in round numbers about ·2 for the first three classes and ·1 for the poll men in head length; about ·15 to ·1 for the same groups for head breadth and about ·1 for the first three classes and ·06 for the poll men in the case of the cephalic index. It is difficult, on the basis of such probable errors, to assert any sensible differences in the class variability. Looking at the series as a whole, we might say with hesitation that possibly 2nd and 3rd class men are more variable in a very slight degree in their head measurements than either brilliant honours men or pass men.

Turning to the school children we again see differences in variability which are often within the probable error of the differences, but occasionally we note considerable divergences. They are difficult to account for, and they do not in any case run parallel with those of the Cambridge graduates. But one general result holds, with two exceptions out of 16 cases, the quick intelligent boys and girls are less variable, and very dull boys and girls more variable than the general population. The exceptions are the very dull boys' cephalic index and the quick intelligent girls' auricular height. Even in the latter case the variability of the very dull girls is sensibly greater than that of the quick intelligent girls. We may therefore say that with a single exception, and that within probable error limits, the quick intelligent are less variable than the very dull. Turning to the Cambridge graduates, we see that with the same exception—cephalic index—the 1st class men are less variable than the poll men. It would accordingly seem probable, that intellectual brilliancy is a more closely selected class than special dullness. Or, perhaps, it would be safer to say that intellectual power is more closely associated with one physical grade than dullness, which is compatible with a wider range of head measurements.

Generally it will be seen, on looking at Tables IX and X or Figs. 5 and 6, that the length of head is more closely associated with intelligence than the breadth, and the breadth than the auricular height. Thus the statement of certain anatomists, that the auricular height is probably the most important head measurement in regard to intelligence is seen to be without statistical basis. The fact that the girls differ from both male children and adults in the nature of the relationship between intelligence and cephalic index is remarkable. I have tested this result in several ways, for example by deducing the intelligence and cephalic index correlations from those of breadth and length with intelligence, but I reach the same conclusion that there is a real change of sign between this correlation for the two sexes, although some methods give the correlation in the girls' case very small and positive, while for the boys it remains between $-·04$ and $-·05$.

(5) *On the Relationship of Ability to other Physical and Mental Characters.*

While the relationship of ability to size and shape of the head has been shown to be very small, it seems worth while to compare it with the values obtained for the correlation with other physical and mental characters. My school measurements enable results to be obtained for the following series:

Physical Characters	*Mental Characters*
Athletic Power	Temper
Health	Popularity
Head Length	Self-Consciousness
Head Breadth	Shyness
Head Height	Conscientiousness
Cephalic Index	Quiet Habits
Hair Colour	and the psycho-physical character
Eye Colour	Handwriting
Curliness of Hair	
Age.	

But the method by which the relationship between intelligence and these characters can be best obtained must be varied with the completeness of classification which it is possible to apply. Thus where one quantity, as in the case of the head measurements and age, is quantitative the correlation ratio η has been determined. Where no quantitative measurement is available but a fairly numerous system of classes as in the case of the relation between intelligence and handwriting, health and hair colour, the method of mean square contingency has been adopted*. Even when one of the characters has only a threefold division, as in the cases of temper, curliness of hair and eye colour, the contingency table gave an 18-fold grouping. In the remaining cases with only two alternatives for one character, we were perforce thrown back on the fourfold division table. But even here many tests were made by dividing the intelligence grouping at more than one point. The chief question is whether the slow intelligent shall in the fourfold division be classed with the intelligent or dull groups. In the case of the boys all the fourfold tables were worked out both ways, and the mean taken of the results, but the labour proved excessive and was abandoned in the case of the girls, the division being taken as nearly as possible through the median—which gives the least probable error—i.e. the quick intelligent and intelligent were taken as a single group.

It will be of value to compare some of the results obtained by different methods.

First, we may take as a comparison of correlation ratio and correlation coefficient found by a fourfold table method:

$$\text{Boys' Breadth of Head and Intelligence}\begin{cases}\text{Correlation Ratio} = \cdot 109 \pm \cdot 014.\\ \text{Correlation Coefficient} = \cdot 084 \pm \cdot 024.\end{cases}$$

Next as a comparison of contingency and fourfold method:

$$\text{Boys' Handwriting and Intelligence}\begin{cases}\text{Mean Square Contingency} = \cdot 283.\\ \text{Correlation Coefficient} = \cdot 312.\end{cases}$$

A more complete comparison may be taken in the case of temper and intelligence in girls. Here four fourfold tables were worked out; the good-natured group were put first with the quick and then with the sullen, and the slow intelligent first with the intelligent and then with the slow.

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* *Drapers' Company Research Memoirs.* Biometric Series I. Dulau and Co.

Girls' temper and intelligence.

$$\text{Correlation Coefficients}\quad \left.\begin{array}{ll}(a) & \cdot162\\ (b) & \cdot304\\ (c) & \cdot140\\ (d) & \cdot279\end{array}\right\}\ \text{Mean}\ \cdot221.$$

Mean Square Contingency = ·192.

Thus while the variation in the correlation coefficient shows that the distribution is not normal, the mean of several fourfold tables gives a result of the same order as, indeed, within the limits of the probable errors, equal to that of mean square contingency.

This is, however, rather an extreme example of variation. Take the following as better illustrations of the double grouping of the slow intelligent:

Boys' Intelligence and Conscientiousness.

Fourfold Table: Correlation Coefficient (*a*) ·464.
(*b*) ·463.

Boys' Intelligence and Popularity.

Fourfold Table: Correlation Coefficient (*a*) ·233.
(*b*) ·220.

Thus we have, I think, reached a reasonably close approximation to the intensity of the relationship between the characters dealt with. It is not contended that the numbers obtained are anything more than a first scale of the relationship between intelligence and the other mental and physical characters. But the general accordance between the results for boys and girls is, even so, remarkable, and the whole series in Table XI may serve as a guide for more complete

TABLE XI.

On the Correlation of Ability with Various Mental and Physical Characters.

Character	Mean (Both sexes)	Boys	Girls
Conscientiousness ...	·45	·46	·43
Handwriting	·29	·28	·30
Popularity	·26	·22	·30
Athletic Power ...	·22	·20	·24
Temper	·21	·19	·22
Health	·18	·17	·19
Head Length	·11	·14	·08
Head Breadth ...	·11	·11	·11
Hair Colour	·10	·10	·09
Shyness	·10	·03	·18
Self-Consciousness ...	·07	·10	·03
Eye Colour	·07	·08	·06
Head Height... ...	·06	·07	·05
Age	·06	·05	·08
Quiet Habits ...	·06	·04	·09
Hair Set	·06	·04	·09
Cephalic Index ...	—	– ·04	·07

future investigations on special characters. Judging the series as a whole, it seems impossible to use any of the physical measurements to estimate intelligence from. Hair colour is practically as good as head length or breadth, and eye colour as good as auricular height, and even all these are more important than the age influence. Health and temper have more relation to intelligence than any of the physical measurements we have made, while the intelligent child is athletic, popular and above all markedly conscientious. Handwriting is doubly as good a test of intelligence as any head measurement. If it be argued that this is merely a schoolmaster's measure of intelligence, then the reply must be that this remains to be proved*. If good handwriting be the schoolmaster's standard of intelligence, it appears also to be—as will be shown on another occasion—his standard of health and popularity. For handwriting, we find, is fairly closely correlated with a number of mental and physical characters. It is interesting to observe that, as far as our data go, the handwriting character-readers ought to be able to predict more closely than the anthropometers not only the amount of intelligence in an individual but also his grade in a variety of other mental and moral characters!

Looked at broadly our table seems to justify fully current common-sense methods of estimating intelligence. Give weight to health, temper, physique, popularity, handwriting and above all conscientiousness, in seeking friend, assistant or servant, and in doing this you will most probably obtain intelligence also. If you wish to take anthropometric characters into account—and they are not worth much—hair and eye colour will be as valuable as head measurements, and you need not produce the callipers in order to observe them! I am not denying that in the future other anthropometric characters may possibly be discovered which will be found to be more closely correlated with intelligence. By all means let them be sought for and investigated biometrically; let all types of head measurements and indices be taken and correlated with ability and achievement; it is worth doing even if it leads to purely negative results. But let us hesitate on the ground of slender, or worse than slender, unscientific evidence to proclaim close association between intelligence and external physical measurements†. So far there is nothing to encourage belief in such association; and if we are consistent and apply any of the dogmatic views currently held to the problem of interracial intelligence, we are led to very remarkable conclusions! I do not propose to discuss this point on the present occasion, nor am I urging the view that the material I now put before the reader for his judgment is to be considered final. I think, however, that it has far more weight than some recent criticisms would admit it to have*. Perhaps, only one who was in continual communication with the collaborators during the measurements and observations can appreciate the conscientious care given to the task, and he alone can estimate the value of the preliminary trials and later tests which were made of the categories and measurements.

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* As far as the non-expert can judge, the classification of the handwritings is a fair one. It is proposed to place the 5000—6000 specimens of handwriting with the ages of the children before an expert and obtain his classification of the whole material.

† Some years ago I was struck by the widespread medical opinion that mentally defective children have peculiarly shaped palates. I asked an exponent of this view for the statistics bearing upon the subject, but I could not find that there had ever been a thorough study of the palate in mentally normal children. In the *American Journal of Insanity*, Vol. LXI. pp. 687—697 will be found a preliminary report of Drs Walter Channing and Clark Wissler: "Comparative Measurements of the Hard Palate in Normal and Feeble-Minded Individuals." They show biometrically that "the absolute size of the palate as measured by the three specified dimensions [height, length and breadth from casts] seems to be the same for feeble-minded and normal individuals," p. 695. It is most unfortunate that quantitative tests so rarely precede the spread and acceptance of very dogmatic opinions in a certain section of the medical profession.

In regard to the association of mental and physical characters, the correlation coefficient may in certain cases screen relationships which are more emphasised by examining the material from other standpoints. I have already pointed out how the correlation ratio and the coefficient of contingency help us in this matter. The regression may indeed not be linear, or there may be, as in the case of hair colour, no scale arrangement beyond criticism. For such cases I have found the old idea of percentages not without value. In the case of intelligence, I take a normal scale as my base line and plot up the percentage of the character for each grade of intelligence along the centroid vertical of the corresponding range, drawing a horizontal line to represent the mean percentage in the population at large. We thus obtain a diagram, which I will venture to term an *analograph* †.

If the percentage increases *or decreases* continually with intelligence (or with the base character, whatever it may be), I term the relationship *homoclinal*; if the percentage does not reach its maximum with the maximum or minimum of intelligence, I term the diagram *heteroclinal*. There may of course be more than one maximum in heteroclinal analographs; the difficulty will be to distinguish true percentage maxima from the 'peaks' due to random sampling. They can, however, be tested in any particular case by the probable errors of the percentages. The advantages of this rough percentage method are: (i) that it enables us to see relationships of a heteroclinal nature, which are screened by a fourfold table method of finding correlation—especially in those cases where neither a correlation ratio nor a coefficient of contingency is calculable on the available data, e.g. in the case of alternative psychical characters, such as noisiness and quietness; and (ii) that it provides a graphic method—more impressive to some minds than any numerical representation—available in cases where it is quite impossible to construct a regression curve.

I propose to deal with the relation of intelligence to other psychical and to non-measurable physical characters in this manner. The data upon which the analographs are based have been collected in Table XII for boys and Table XIII for girls. The small number of children recorded as *Very Dull* leads to a large probable error in the percentages of this category. I have accordingly classed the

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* A reply to the criticisms of G. U. Yule will shortly be published.

† ἀνάλογον + γράφω, the former from Euclid, Book V., and the contraction is tolerable as in ἀμφορεύς.

TABLE XII. *Percentage Changes in Boys' Characteristics.*

Intellectual Grade.

	Q. I.	I.	S. I.	S.	S. D.		V. D.	Totals
Eye Colour								
Light	41·41	40·28	36·00	36·34	45·74	(**42·73**)	32·91	38·59
Medium	40·27	37·28	42·14	42·03	29·84	(**34·72**)	50·63	39·76
Dark	18·32	22·44	21·86	21·62	24·42	(**22·55**)	16·46	21·65
Hair Set								
Smooth	82·98	83·49	85·25	82·31	84·39	(**84·44**)	84·62	83·89
Wavy	13·50	13·04	11·05	14·40	12·64	(**12·68**)	12·82	12·63
Curly	3·52	3·47	3·70	3·29	2·97	(**2·88**)	2·56	3·48
Health								
Robust	38·82	42·34	41·16	35·90	35·48	(**30·79**)	15·24	39·68
Normally Healthy	44·36	44·66	42·65	40·95	41·36	(**41·81**)	43·29	43·20
Delicate	16·82	13·00	16·19	23·15	23·16	(**27·40**)	41·47	17·11
Hair Colour								
Red	2·66	3·53	4·74	3·43	1·65	(**3·57**)	8·51	3·82
Fair	39·54	35·79	32·50	36·79	33·68	(**31·40**)	25·53	34·96
Brown	31·56	30·12	33·94	36·05	37·81	(**37·95**)	38·30	33·02
Dark	26·24	30·56	28·82	23·73	26·86	(**27·08**)	27·66	28·20
Conscientiousness								
Keen	89·90	79·67	64·15	46·41	37·79	(**36·45**)	31·76	67·24
Dull	10·10	20·33	35·85	53·59	62·21	(**63·55**)	68·24	32·76
Shy	58·52	59·19	58·48	58·72	58·86	(**59·48**)	61·64	58·82
Self-Assertive	41·48	40·81	41·52	41·28	41·14	(**40·52**)	38·36	41·18
Self-Conscious	54·42	48·98	50·45	45·04	33·03	(**34·36**)	39·44	48·27
Unself-Conscious	45·58	51·02	49·55	54·96	66·97	(**65·64**)	60·56	51·73
Noisy	30·82	36·32	34·71	37·59	39·34	(**38·89**)	37·35	35·48
Quiet	69·18	63·68	65·29	62·41	60·66	(**61·11**)	62·65	64·52
Popular	89·65	84·38	79·47	75·47	61·06	(**62·28**)	67·27	80·51
Unpopular	10·35	15·62	20·53	24·53	38·94	(**37·72**)	32·73	19·49
Handwriting								
Good	63·16	48·32	36·20	29·74	24·41	(**21·04**)	11·69	41·07
Moderate	30·89	39·50	44·31	42·00	48·12	(**48·79**)	50·65	41·21
Bad	5·95	12·18	19·49	28·26	27·47	(**30·17**)	37·66	17·72
Temper								
Quick	21·07	20·56	19·32	12·39	14·89	(**15·02**)	15·39	18·46
Goodnatured	74·38	71·89	67·84	68·59	55·75	(**53·03**)	44·87	68·88
Sullen	4·55	7·55	12·84	19·02	29·36	(**31·95**)	39·74	12·66
Athletic	77·62	72·09	65·47	61·41	45·51	(**45·26**)	44·44	67·21
Non-Athletic	22·38	27·91	34·53	38·59	54·49	(**54·74**)	55·56	32·79

TABLE XIII. *Percentage Changes in Girls' Characteristics.*

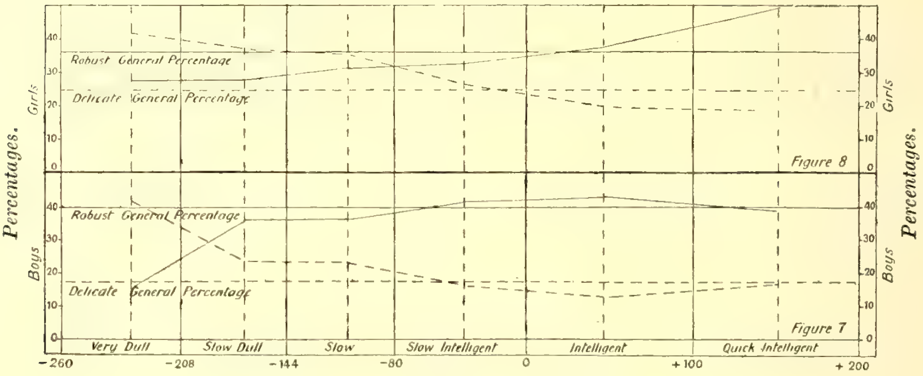
Intellectual Grade.

	Q. I.	I.	S. I.	S.	S. D.		V. D.	Totals
Eye Colour								
Light	36·31	34·82	32·04	33·33	36·28	**(35·48)**	33·33	34·09
Medium	45·96	42·37	45·08	42·61	43·36	**(42·26)**	39·29	43·74
Dark	17·73	22·81	22·88	24·06	20·36	**(22·26)**	27·38	22·17
Hair Set								
Smooth	62·32	64·25	66·77	66·10	64·86	**(65·10)**	65·79	65·01
Wavy	28·26	25·14	23·25	19·89	18·02	**(17·45)**	15·79	23·83
Curly	9·42	10·61	9·98	14·01	17·12	**(17·45)**	18·42	11·16
Health								
Robust	49·70	36·41	32·88	31·18	27·68	**(27·74)**	27·91	36·04
Normally Healthy	31·72	43·70	40·86	33·80	35·27	**(33·87)**	30·23	39·17
Delicate	18·58	19·89	26·26	35·02	37·05	**(38·39)**	41·86	24·79
Hair Colour								
Red	6·14	3·99	3·36	2·15	3·69	**(3·99)**	4·76	3·88
Fair	39·01	34·32	38·09	34·79	37·33	**(38·37)**	41·07	36·48
Brown	37·27	39·47	35·34	41·95	36·63	**(36·88)**	37·50	38·02
Dark	17·58	22·22	23·21	21·11	22·35	**(20·76)**	16·67	21·62
Conscientiousness								
Keen	86·15	83·62	68·69	55·21	39·33	**(36·05)**	28·75	72·85
Dull	13·85	16·38	31·31	44·79	60·67	**(63·95)**	71·25	27·15
Shy	48·52	62·42	70·02	72·24	63·37	**(61·35)**	56·25	64·01
Self-Assertive ...	51·48	37·58	29·98	27·76	36·33	**(38·65)**	43·75	35·99
Self-Conscious ...	48·02	48·77	48·62	52·64	54·69	**(54·48)**	53·95	49·51
Unself-Conscious ...	51·98	51·23	51·38	47·36	45·31	**(45·52)**	46·05	50·49
Noisy	38·59	32·26	28·10	28·95	30·36	**(32·04)**	36·47	31·49
Quiet	61·41	67·74	71·90	71·05	69·64	**(67·96)**	63·53	68·51
Popular	90·54	84·70	79·58	67·04	59·55	**(53·25)**	36·76	79·59
Unpopular	9·46	15·30	20·42	32·96	40·45	**(46·75)**	63·24	20·41
Handwriting								
Good	59·88	51·39	39·23	26·40	23·47	**(22·39)**	19·44	43·50
Moderate	26·22	36·71	44·62	48·28	43·88	**(42·54)**	38·89	39·56
Bad	13·90	11·89	16·15	25·32	32·65	**(35·07)**	41·67	16·94
Temper								
Quick	24·01	20·26	15·65	14·14	10·93	**(11·31)**	12·65	17·90
Goodnatured ...	68·21	68·78	69·68	64·14	57·38	**(56·23)**	54·82	67·43
Sullen	7·78	10·96	14·67	21·72	32·79	**(32·46)**	32·53	14·67
Athletic	69·21	62·10	54·06	44·57	36·78	**(37·07)**	37·93	56·71
Non-Athletic ...	30·79	37·90	45·94	55·43	63·22	**(62·93)**	62·07	43·29

Slow Dull and *Very Dull* together and calculated the corresponding percentages in the heavy bracketed figures*.

Health and Intelligence. We see that for both boys and girls we have sensibly homoclinal systems. The robust children among dull and slow children are much below the general percentage, and rise above it for the able children. Conversely the delicate children are below the general percentage on the intelligent side, and rise much above it on the dull side. There is one peculiarity which, I think, is not an irregularity of random sampling, but a sexual difference. Among the *Quick Intelligent* boys there is a smaller percentage of robust and a larger percentage of delicate than among the *Intelligent* boys. Thus, while ability is associated with health, a certain number of weakly boys are markedly intelligent. With the girls, on the other hand, the *Quick Intelligent* have the largest percentage of robust cases. And this is, perhaps, what one would, from the standpoint of national efficiency, prefer—i.e. the closest association of strength and intelligence. A further sexual difference is that the percentage of robust girls is smaller and the percentage of delicate girls is larger than in the case of boys.

Analograph of Health and Intelligence.



Scale of Intelligence in Mentaces.

Pigmentation and Intelligence. Both hair and eye colour clearly provide heteroclinal systems, but it is difficult to trace any nomic relationship in either the numbers or the graphs. Thus, while brown-haired boys give a fairly smooth homoclinal graph, showing decreasing percentages with increasing intelligence, there is no corresponding feature in brown-haired girls, the deviation from the

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* The following are sufficiently closely for practical purposes the mean values of each intellectual grade:

Mentally Defective	−317 mentaces.	Fair Intelligence	+ 22 mentaces.
Very Dull	−238 ,,	Capable	+ 71 ,,
Slow Dull	−170 ,,	Specially Able	+151 ,,
Slow	−108 ,,	Genius	+317 ,,
Slow Intelligent	− 38 ,,		

general percentage being very irregular. Dark-haired children of both sexes have a maximum in the *Intelligent* to *Slow Intelligent*, there being fewer than the normal number of both the very able and the very stupid. The analographs for dark boys and girls run very parallel, and I think there can hardly be a doubt that the very dark are not up to the average in either extreme ability or extreme dullness. While the total of brown and dark boys is closely equal to the total of brown and dark girls, there is a sensibly larger percentage of dark boys than girls in these records. The total percentages of red-haired children is strikingly alike for the two sexes. There appears, as far as the slender material enables us to judge, however, a sexual difference in their distribution of intelligence. Disregarding the distinction between *Slow Dull* and *Very Dull*, as the numbers are too scanty to use apart, we find that red-haired boys are most numerous among the *Slow Intelligent*, while red-haired girls have a reversed heteroclisy, being most frequent among the *Quick Intelligent* or the *Very Dull*. To some extent these results are confirmed by the data for eye colour; in the case of both boys and girls the *Quick Intelligent* group contains less than the general percentage of dark-eyed children. The fair children, on the other hand, are in excess in the *Quick Intelligent* and the total *Dull* group. Thus light-eyed children have a slight tendency to the extremes and dark to mediocrity.

As a whole, while I note some traces of relationship of intelligence to pigmentation, there is not enough to justify any sweeping assertions. While not very hopeful, I think it would be worth while making a much finer classification with actual eye and hair scales; it would be a laborious piece of work, but there is just the indication that it might lead to more definite relationships.

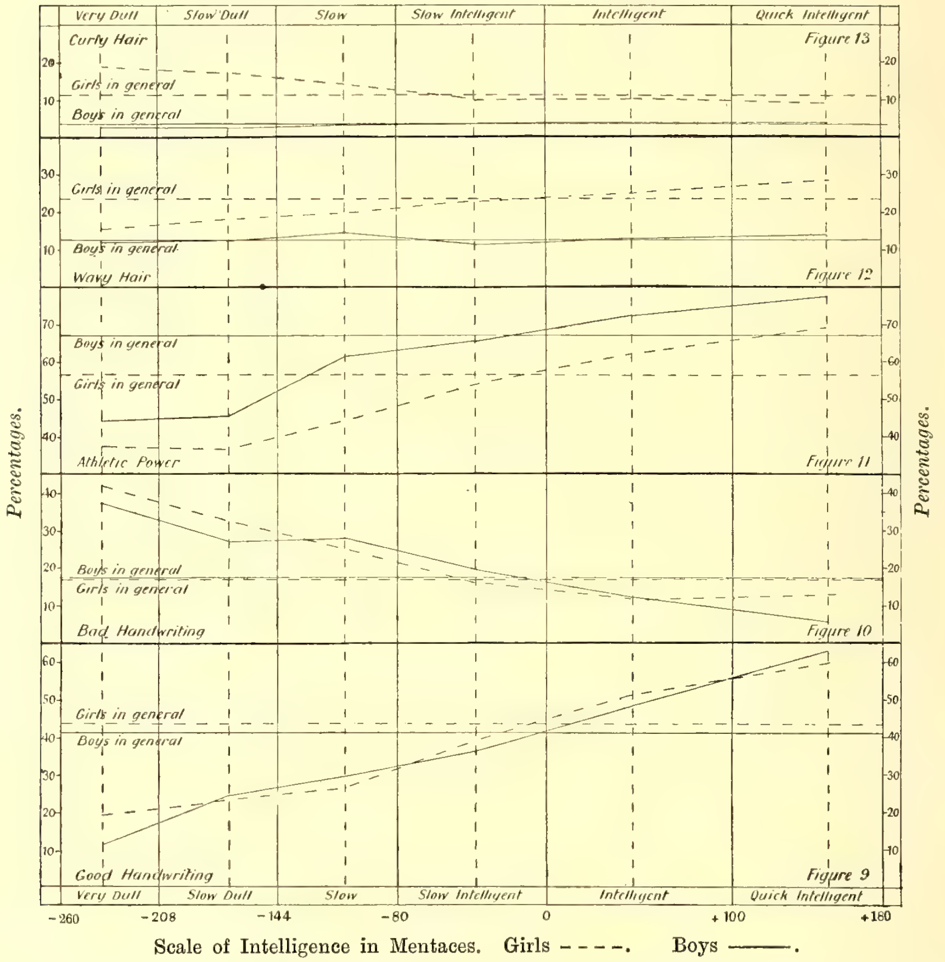
Hair Set. Here again we have some rather marked sexual differences. Curliness in boys decreases as we pass from the intelligent to the dull end of the scale. In girls it is precisely the opposite; curly-haired girls are three times as frequent as curly-haired boys, but the percentage of curly dull girls is twice that of curly and quick intelligent girls. On the other hand, wavy hair, which is heteroclinal for boys, has a well-marked homoclinal *analograph* for girls, intelligent girls having more frequently wavy hair than dull girls. These points are indicated in Figs. 12 and 13.

I now pass to a series of characteristics which are on the borderland between the psychical and physical—Handwriting, Athletic Power, and Temper—all of which have well-marked homoclinal analographs.

Handwriting. Figs. 9 and 10 indicate how markedly, for both boys and girls, good handwriting decreases and bad handwriting increases with the transition from intelligence to dullness.

Athletic Power. Fig. 11 shows how the percentages of both non-athletic boys and girls are more than doubled as we pass from the quick intelligent to the dull groups. The athletic character in children, at any rate, is markedly associated with intelligence.

Analographs of Various Characters for each Grade of Intelligence.



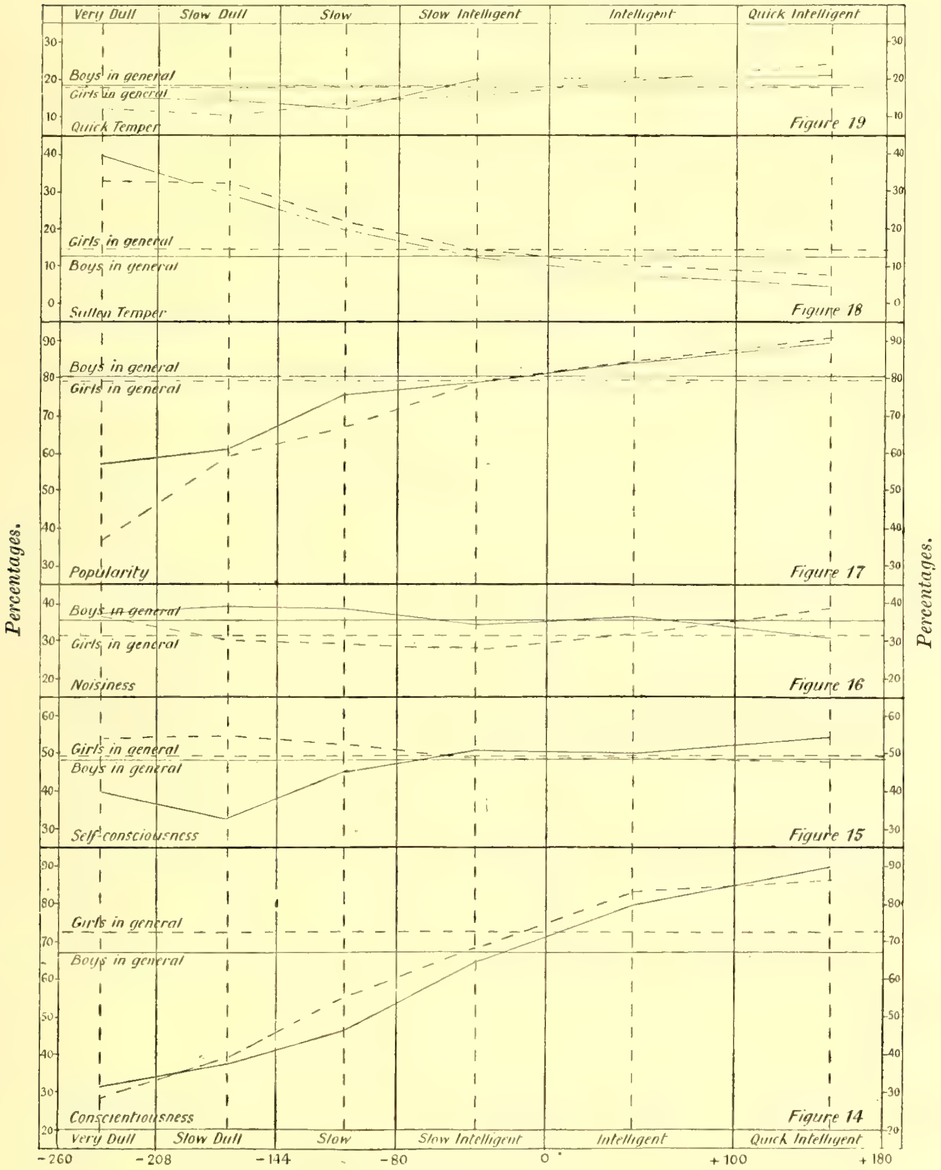
Temper. Fig. 18 indicates the great rise in sullen temper when we turn from intelligence to dullness. If we consider the analographs for *Quick Temper* (Fig. 19), we see that the ablest children are the most *Quick Tempered*; but there is a tendency to a heteroclinal system, more marked in boys than girls, the dull having again a tendency to quick temper.

In the more purely psychical alternatives of our observations, there are certain marked relations and certain noteworthy sexual differences.

Conscientiousness. Fig. 14 shows that intelligence is homoclinal to conscientiousness, there being in both sexes a reduction to about a third of the percentage between the very intelligent and very dull classes.

Shyness. This character seems to have no relation to ability in boys; in girls it is sensibly related to slowness, the intelligent and the dull being alike wanting in their due proportion of shyness.

Analographs of Various Characters for each Grade of Intelligence.



Scale of Intelligence in Mentaces. Girls – – – –. Boys ———.

Self-consciousness. Here there is a marked sexual difference; while self-consciousness is not closely related to intelligence, still it is the clever boys and the dull girls who are self-conscious in the higher degree: see Fig. 15.

Quiet Habits. The analograph for the girls is heteroclinal, the able and the dull being noisy and the slow being quiet. The relationship is less marked in boys, but the intelligent boys are quieter than the dull boys.

Popularity. While the percentage of popular children is almost exactly the same for both sexes, and the intelligent children are more popular than the dull ones, yet the relationship is more marked in girls than boys: see Fig. 17.

To sum up, then: While no characters in school children so far dealt with show very high correlation with intelligence, we may yet say that the intelligent boy is markedly conscientious, is moderately robust, athletic, and popular; he tends rather to quick than to sullen temper. He is more self-conscious and quieter than the dull boy; he has a *slightly* bigger head, and possibly lighter pigmentation than those of more mediocre intelligence. His hair has a larger percentage of curliness.

The intelligent girl also is markedly conscientious, moderately robust, athletic, and popular. She, too, tends to quick rather than sullen temper. She is less self-conscious than the dull girl, and noisier than the girl of mediocre intelligence. It is the slow girl who is quiet and shy. The intelligent girl has a slightly bigger head than the dull girl, and her hair is more likely to be wavy and much less likely to be curly.

It may possibly be hinted that these results are of little significance, and, had they not been so, they could still have been deduced—without elaborate statistics—from the impressions of a careful and observant teacher. It may be so, but much of science is the verification or refutation of impressions and opinions, and the mainly negative conclusions of this paper place at any rate on a sounder quantitative basis the view that even for the mass, and therefore much more for the individual, little can be judged as to intelligence from the more obvious anthropometric measurements and the more easily noted psychical characteristics of children.

The onus of proof that other measurements and more subtle psychical observations would lead to more definite results may now, I think, be left to those who *a priori* regard such an association as probable. Personally, the result of the present enquiry has convinced me that there is little relationship between the external physical, and the psychical characters in man. Future papers from my laboratory, while showing certain definite relationships, will serve to confirm this view, as far as the present material is concerned.

In the tables with which this memoir concludes, we have the full classification possible of the raw material. The tables for the three diameters and intelligence in the case of girls are due to my friend Dr M. Greenwood; that for cephalic index and intelligence in Cambridge graduates is due to Miss A. Barrington. The remaining 42 tables are due both in construction and reduction to Dr A. Lee. I have not only to thank her for so much aid, but also to acknowledge heartily the generosity of the Worshipful Company of Drapers, which has rendered it possible for my statistical laboratory to retain the services of such an efficient computator and assistant.

APPENDIX.

A. CAMBRIDGE GRADUATES.

TABLE XIV. *Length of Head in inches.*

		6·9	*7·0*	*7·1*	*7·2*	*7·3*	*7·4*	*7·5*	*7·6*	*7·7*	*7·8*	*7·9*	*8·0*	*8·1*	*8·2*	*8·3*	*8·4*	*8·5*	*8·6*	Totals
Intellectual Grade.	1st Class Honours	—	—	2	2	10	10	18	26	29	22	14	11	6	2	1	—	—	—	153
	2nd Class Honours	—	3	2	2	8	12	29	39	27	22	19	10	8	—	—	—	—	1	182
	3rd Class Honours	—	—	5	5	11	12	31	37	22	26	16	14	6	3	1	—	—	—	189
	Poll men	2	2	8	28	26	48	76	82	85	56	39	17	9	7	2	—	—	—	487
	Totals	2	5	17	37	55	82	154	184	163	126	88	52	29	12	4	—	—	1	1011

TABLE XV. *Breadth of Head in inches.*

		5·5	*5·6*	*5·7*	*5·8*	*5·9*	*6·0*	*6·1*	*6·2*	*6·3*	*6·4*	*6·5*	*6·6*	*6·7*	*6·8*	Totals
Intellectual Grade.	1st Class Honours	—	1	3	9	14	31	40	19	23	8	3	2	—	—	153
	2nd Class Honours	—	—	11	11	28	47	33	29	13	5	2	3	—	—	182
	3rd Class Honours	—	1	8	11	22	44	39	29	16	10	2	5	1	1	189
	Poll men	2	7	12	40	70	106	105	65	50	20	5	4	1	—	487
	Totals	2	9	34	71	134	228	217	142	102	43	12	14	2	1	1011

TABLE XVI. *Cephalic Index.*

		72	*73*	*74*	*75*	*76*	*77*	*78*	*79*	*80*	*81*	*82*	*83*	*84*	*85*	*86*	*87*	*88*	*89*	*90*	*91*	*92*	Totals
Intellectual Grade.	1st Class Honours	·5	2·5	6	5	10	11	18	24	23	12·5	15	8·5	9	3·5	3·5	·5	·5	—	—	—	—	153
	2nd Class Honours	·5	5·5	4	7	14	21·5	28	23	27	16·5	8·5	9	7	3·5	2·5	1·5	—	2	1	—	—	182
	3rd Class Honours	—	1	7	10	11	14	28	22·5	26·5	20·5	17	17	2·5	3	4·5	3	·5	1	—	—	—	189
	Poll men	3	1	9	14	22·5	56·5	59	76·5	74·5	57	32	35	22·5	12	5·5	3	2	—	1	—	1	487
	Totals	4	10	26	36	57·5	103	133	146	151	106·5	72·5	69·5	41	22	16	8	3	3	2	—	1	1011

B. SCHOOL CHILDREN. HEAD MEASUREMENTS. REDUCED TO 12 YEARS OF AGE.

TABLE XVII.

Boys' Head Length in cms.

Intellectual Grade.	*162·5—164·5*	*164·5—166·5*	*166·5—168·5*	*168·5—170·5*	*170·5—172·5*	*172·5—174·5*	*174·5—176·5*	*176·5—178·5*	*178·5—180·5*	*180·5—182·5*	*182·5—184·5*	*184·5—186·5*	*186·5—188·5*	*188·5—190·5*	*190·5—192·5*	*192·5—194·5*	*194·5—196·5*	*196·5—198·5*	*198·5—200·5*	*200·5—202·5*	*202·5—204·5*	*204·5—206·5*	Totals
Quick Intelligent	—	2	—	1·5	4·5	3·5	9·5	16·5	17·5	21·5	41	36	44	27	18	14	9	5	4	1	1	—	276·5
Intelligent ...	—	1	4·5	9·5	15·5	13·5	26·5	39	64	72	111	96·5	82·75	78·75	54	29	20	7·5	6	3	1	2	737
Slow Intelligent	—	1	1	6	14·5	22·5	31	47·5	68	88	90·5	93	83·75	72·75	57·5	39	17·5	16·5	6·5	2	—	—	758·5
Slow ...	—	—	·5	10·5	5·5	15·5	15·5	30	27·5	34·75	53·75	33	26·5	31	26·5	9·5	12	9	4	·5	—	—	345·5
Slow Dull ...	2	—	1	4	9·5	8	8	10	13·5	11·25	13·75	14·5	11	12·5	8	2·5	5·5	—	2	—	—	—	137
Very Dull ...	1	1	1	·5	2·5	4	1	3·5	6	8	7·5	1	1	1	1·5	2	1	—	—	—	—	—	43·5
Totals ...	3	5	8	32	52	67	91·5	146·5	196·5	235·5	317·5	274	249	223	165·5	96	65	38	22·5	6·5	2	2	2298

TABLE XVIII.

Girls' Head Length in cms.

Intellectual Grade.	*158·5—160·5*	*160·5—162·5*	*162·5—164·5*	*164·5—166·5*	*166·5—168·5*	*168·5—170·5*	*170·5—172·5*	*172·5—174·5*	*174·5—176·5*	*176·5—178·5*	*178·5—180·5*	*180·5—182·5*	*182·5—184·5*	*184·5—186·5*	*186·5—188·5*	*188·5—190·5*	*190·5—192·5*	*192·5—194·5*	*194·5—196·5*	*196·5—198·5*	*198·5—200·5*	Totals
Quick Intelligent	—	—	1	1	5·5	7·5	11·5	13	24	49·5	47	44	33	31	17	10·5	9·5	5·5	4	2	—	316·5
Intelligent ...	2	—	—	11	14	20	35	45	71	96·5	107·5	98·5	86	66·5	52·5	35	21	10·5	6·5	1	1	780·5
Slow Intelligent	·5	2·5	2	12·5	12	18	30	35·5	65	76	101	79·5	73	51	57	23	10·5	6·5	4	5	—	664·5
Slow ...	1	1	—	5	5	9	12·5	19·5	28·5	37	33·5	27	36	18	14	14·5	8	3	4	—	—	276·5
Slow Dull ...	—	—	—	2	3	2·5	7·5	15	11·5	10·5	19	13	9·5	3·5	4	5	1	1	1	—	—	109
Very Dull ...	—	·5	1·5	1	2	—	1	2·5	7·5	7	1	—	9	4	2	1	—	1	—	—	—	41
Totals ...	3·5	4	4·5	32·5	41·5	57	97·5	130·5	207·5	276·5	309	262	246·5	174	146·5	89	50	27·5	19·5	8	1	2188

TABLE XIX.

Boys' Head Breadth in cms.

Intellectual Grade.	*121·5—123·5*	*123·5—125·5*	*125·5—127·5*	*127·5—129·5*	*129·5—131·5*	*131·5—133·5*	*133·5—135·5*	*135·5—137·5*	*137·5—139·5*	*139·5—141·5*	*141·5—143·5*	*143·5—145·5*	*145·5—147·5*	*147·5—149·5*	*149·5—151·5*	*151·5—153·5*	*153·5—155·5*	*155·5—157·5*	*157·5—159·5*	*159·5—161·5*	Totals
Quick Intelligent	—	—	1	—	1	5	5	4·5	12·5	23	28	40·5	35·5	41·5	32·5	17	10·5	10	6	3	276·5
Intelligent ...	1	—	—	2	15	5	16	27	34·5	76	85·5	96	104	92·5	76	56	23	12	8	4	733·5
Slow Intelligent	—	—	—	3	4	5	16	28·5	38·5	85·5	102·5	104	104	108	76	42·5	27	10	4	4	762·5
Slow	—	1	1	3	2	5	9	19	25·5	36·5	47	45	47	42	28	16·5	11	7·5	1	1	348
Slow Dull ...	—	—	—	1	—	5	3	7	11	17	14	22·5	21	10·5	8·5	7	3	2	3	—	135·5
Very Dull ...	—	—	—	—	1	1	3	3	4	5	3	8	4	3·5	3·5	1	3	—	—	—	43
Totals ...	1	1	2	9	23	26	52	89	126	243	280	316	315·5	298	224·5	140	77·5	41·5	22	12	2299

TABLE XX.

Girls' Head Breadth in cms.

Intellectual Grade.	*112·5—114·5*	*114·5—116·5*	*116·5—118·5*	*118·5—120·5*	*120·5—122·5*	*122·5—124·5*	*124·5—126·5*	*126·5—128·5*	*128·5—130·5*	*130·5—132·5*	*132·5—134·5*	*134·5—136·5*	*136·5—138·5*	*138·5—140·5*	*140·5—142·5*	*142·5—144·5*	*144·5—146·5*	*146·5—148·5*	*148·5—150·5*	*150·5—152·5*	*152·5—154·5*	*154·5—156·5*	*156·5—158·5*	*158·5—160·5*	*160·5—162·5*	Totals
Quick Intelligent	—	—	—	—	3	—	1·5	1·5	6·5	14	18·5	22	43·5	32·5	35	42·5	34·5	25	18·5	7	4	1·5	·5	·5	—	312
Intelligent ...	—	2	1·5	3	3·5	4·5	7	6·5	20	30	44·5	38·5	73	103·5	104·5	111·5	74	74·5	39·5	13	8	3	1·5	1	—	768
Slow Intelligent	—	—	2	4	4	5	6	9·5	14	30	27·5	45·5	60	72·5	103	86·5	70·5	60	33	13·5	12	4	1	—	1	664·5
Slow	—	—	1	3	2	2	1	2·5	2·5	8	8	23·5	45·5	50·5	40	24	21·5	25	7·5	3·5	2	1	—	2	—	276
Slow Dull ...	1	—	—	—	2	1	—	5	3	6	6	8·5	17	9	13	14·5	8	6·5	3	2	—	—	—	—	—	105·5
Very Dull ...	1	1	—	—	·5	·5	3	1	2	4·5	3·5	—	2	5	5·5	·5	6	—	1	—	2	—	—	—	—	39
Totals ...	2	3	4·5	10	15	13	18·5	26	48	92·5	108	138	241	273	301	279·5	214·5	191	102·5	39	28	9·5	3	3·5	1	2165

TABLE XXI.

Boys' Auricular Height in cms.

Intellectual Grade.	*103·5—105·5*	*105·5—107·5*	*107·5—109·5*	*109·5—111·5*	*111·5—113·5*	*113·5—115·5*	*115·5—117·5*	*117·5—119·5*	*119·5—121·5*	*121·5—123·5*	*123·5—125·5*	*125·5—127·5*	*127·5—129·5*	*129·5—131·5*	*131·5—133·5*	*133·5—135·5*	*135·5—137·5*	*137·5—139·5*	*139·5—141·5*	*141·5—143·5*	*143·5—145·5*	*145·5—147·5*	Totals
Quick Intelligent	—	1	—	1	2	2	4·5	10·5	18·5	20·75	33·25	35	43·5	31	23	14	12·5	10	5	4·5	3	1	276
Intelligent ...	·5	2·5	4·5	5	4	9	25·25	39·75	55	59·25	76	94·25	80·5	87	60	44	29·75	22·75	22	5	4·5	—	730·5
Slow Intelligent	—	—	·5	4·5	5	9	28·75	43	45·25	75·5	79·25	91·75	100·5	87·5	62	43·5	31·5	19	17·5	10	5·5	1	760·5
Slow ...	—	—	1	·5	2·5	7	11	19·75	21·25	27·5	40·5	35	31	49	34·5	24	14·75	12·75	8·5	4·5	1	—	346
Slow Dull ...	—	—	—	1	1·5	2	6	7	12·5	11·5	19	19	9·5	17	10	6·5	5·5	4·5	—	2	1	—	135·5
Very Dull ...	—	—	—	2·5	·5	2·5	3	1	1	4	6	4·5	6	3·5	4	1	1	1	—	—	—	—	41·5
Totals ...	·5	3·5	6	14·5	15·5	31·5	78·5	121	153·5	198·5	254	279·5	271	275	193·5	133	95	70	53	26	15	2	2290

TABLE XXII.

Girls' Auricular Height in cms.

Intellectual Grade.	*103·5—105·5*	*105·5—107·5*	*107·5—109·5*	*109·5—111·5*	*111·5—113·5*	*113·5—115·5*	*115·5—117·5*	*117·5—119·5*	*119·5—121·5*	*121·5—123·5*	*123·5—125·5*	*125·5—127·5*	*127·5—129·5*	*129·5—131·5*	*131·5—133·5*	*133·5—135·5*	*135·5—137·5*	*137·5—139·5*	*139·5—141·5*	*141·5—143·5*	*143·5—145·5*	Totals
Quick Intelligent	1	2	1·5	3	10	16	14	20	33·5	31	47·5	28	33	21	17	13	10	2	3	2	—	308·5
Intelligent ...	1	3	6·5	10	12	29·5	26·5	65	91	105·5	91	90	74	60	39·5	27	12	11·5	5	3	5	768
Slow Intelligent	—	3	6	8	11	32·5	36·5	56	58·5	89·5	82·5	84	61·5	40·5	25	37·5	10	11·5	8	4	3	668·5
Slow ...	—	1	4	5	6	10	15	14	40	36	29	26	32·5	17·5	19	9	2	3	4	3	1	277
Slow Dull ...	—	1	2	2	3	5	10	10	11	11	13	16	9	5	3	2	3	—	1	—	—	107
Very Dull ...	—	—	1	1	1	2	2	1	8	5	1	5	2	1	3	1	2	1	—	—	—	37
Totals ...	2	10	21	29	43	95	104	166	242	278	264	249	212	145	106·5	89·5	39	29	21	12	9	2166

TABLE XXIII.

Boys' Cephalic Index.

Intellectual Grade.	67—68	68—69	69—70	70—71	71—72	72—73	73—74	74—75	75—76	76—77	77—78	78—79	79—80	80—81	81—82	82—83	83—84	84—85	85—86	86—87	87—88	88—89	89—90	90—91	Totals
Quick Intelligent	—	—	1	2	3·5	2	8	11	18·5	37	29	36	31·5	22·5	30·5	25	15·5	4·5	3	3·5	1·5	—	—	—	285·5
Intelligent ...	—	1·5	3·5	3·5	8·5	16	20·5	24	52·5	81	86·5	112	80·25	80·25	64	50	23	27·5	11·5	7	6·5	2·5	1	1	764
Slow Intelligent	1	·5	·5	1	7·5	7·5	28	28·25	60·25	59·5	103	126	92·75	78·25	56	37·25	31·75	16·5	11·5	10	1	2	1	1	762
Slow	—	—	—	2	3	3	14·5	18·25	31·75	36·5	36	45·5	51	28·5	34	16·75	16·25	7	5	4	—	—	—	—	353
Slow Dull ...	—	1	—	—	1	1	4·5	6	8·5	14	13	24	13	14·5	6	13	10	4	2	—	—	1	1	—	137·5
Very Dull ...	—	—	—	—	—	—	1	1	5	2	5	7·5	4	5	3·5	4	1	2	—	1	·5	·5	—	—	43
Totals ...	1	3	5	8·5	23·5	29·5	76·5	88·5	176·5	230	272·5	351	272·5	229	194	146	97·5	61·5	33	25·5	9·5	6	3	2	2345

TABLE XXIV.

Girls' Cephalic Index.*

Intellectual Grade.	60·5—62·5	62·5—64·5	64·5—66·5	66·5—68·5	68·5—70·5	70·5—72·5	72·5—74·5	74·5—76·5	76·5—78·5	78·5—80·5	80·5—82·5	82·5—84·5	84·5—86·5	86·5—88·5	88·5—90·5	90·5—92·5	Totals
Quick Intelligent	1	—	—	1	7	13	24·5	37	67·5	84·5	56	23·5	10	2	1	1	329
Intelligent ...	1·5	2·5	5	6·5	9·5	21·5	57	112	170·25	165·25	130	66	26·5	5	5	—	783·5
Slow Intelligent	—	5	3	3·5	7·5	22·5	44·5	81·5	150·25	164·75	104·5	58·5	30	6	1	—	682·5
Slow	—	2·5	1·5	1	4	9	13·5	33·5	67·5	83	37·5	18	8	2	3	—	284
Slow Dull ...	—	1	1	—	2·5	5·5	6	16	28	24·5	15·5	2	2·5	·5	1	—	106
Very Dull ...	—	—	—	1	3	4	4	5	11	3	6	1	2	1	—	—	41
Totals ...	2·5	11	10·5	13	33·5	75·5	149·5	285	494·5	525	349·5	169	79	16·5	11	1	2226

* By an oversight of the computator the units of cephalic index were here taken not the same as in Table XXIII.

TABLE XXV.

Boys' Health.

Intellectual Grade.	Very Robust	Robust	Normally Healthy	Rather Delicate	Very Delicate	Totals
Quick Intelligent ...	28	77	120	40·5	5	270·5
Intelligent ...	46·5	272·5	336·5	92	6	753·5
Slow Intelligent ...	36	266·5	313·5	111	8	735
Slow	19	102	138	76	2	337
Slow Dull	6	42·25	56·25	29·5	2	136
Very Dull	3	3·25	17·75	14	3	41
Totals ...	138·5	763·5	982	363	26	2273

TABLE XXVI.

Girls' Health.

Intellectual Grade.	Very Robust	Robust	Normally Healthy	Rather Delicate	Very Delicate	Totals
Quick Intelligent ...	31	135·5	106·25	58·25	4	335
Intelligent ...	39·5	256·5	355·25	142·25	19·5	813
Slow Intelligent ...	39·5	189	284	166·5	16	695
Slow	15	74·5	97	89·5	11	287
Slow Dull	5	26	39·5	37·5	4	112
Very Dull	3	9	13	15	3	43
Totals ...	133	690·5	895	509	57·5	2285

TABLE XXVII.

Boys' Hair Colour.

Intellectual Grade.	Red	Fair	Brown	Dark	Jet Black	Totals
Quick Intelligent ...	7	104	83	64	5	263
Intelligent ...	26	263·25	221·5	214·75	10	735·5
Slow Intelligent ...	35·5	243·25	254	200·25	15·5	748·5
Slow	11·5	123·25	120·75	73·5	6	335
Slow Dull ...	2	40·75	45·75	30·5	2	121
Very Dull ...	4	12	18	12	1	47
Totals ...	86	786·5	743	595	39·5	2250

TABLE XXVIII.

Girls' Hair Colour.

Intellectual Grade.	Red	Fair	Brown	Dark	Jet Black	Totals
Quick Intelligent ...	20·25	128·75	123	57	1	330
Intelligent ...	32·5	279·5	321·5	172·5	8·5	814·5
Slow Intelligent ...	23·25	263·75	244·75	153·75	7	692·5
Slow	6	97·25	117·25	55	4	279·5
Slow Dull ...	4	40·5	39·75	23·25	1	108·5
Very Dull ...	2	17·25	15·75	7	—	42
Totals ...	88	827	862	468·5	21·5	2267

TABLE XXIX.

Boys' Hair Set.

Intellectual Grade.

		Quick Intelligent	Intelligent	Slow Intelligent	Slow	Slow Dull	Very Dull	Totals
Hair Type.	Smooth ...	212	613·25	588·25	263	113·5	33	1823
	Wavy ...	34·5	95·75	76·25	46	17	5	274·5
	Curly ...	9	25·5	25·5	10·5	4	1	75·5
	Totals	255·5	734·5	690	319·5	134·5	39	2173

TABLE XXX.

Girls' Hair Set.

Intellectual Grade.

		Quick Intelligent	Intelligent	Slow Intelligent	Slow	Slow Dull	Very Dull	Totals
Hair Type.	Smooth ...	198·5	460	415	174·5	72	25	1345
	Wavy ...	90	180	144·5	52·5	20	6	493
	Curly ...	30	76	62	37	19	7	231
	Totals	318·5	716	621·5	264	111	38	2069

TABLE XXXI.

*Boys' Eye Colour**.

Intellectual Grade.

		Quick Intelligent	Intelligent	Slow Intelligent	Slow	Slow Dull	Very Dull	Totals
Eye Colour.	Light ...	108·5	295·25	263·5	127·75	59	13	867
	Medium ...	105·5	273·25	308·5	147·75	38·5	20	893·5
	Dark ...	48	164·5	160	76	31·5	6·5	486·5
	Totals	262	733	732	351·5	129	39·5	2247

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* In this investigation, "Light" covered blue of all shades, light grey, very light green, "Medium" included dark grey, green, light chestnut, orange and grey combined, and "Dark" was taken to embrace dark chestnut, light and dark brown, "black."

TABLE XXXII.

Girls' Eye Colour.

Intellectual Grade.

Eye Colour.	Quick Intelligent	Intelligent	Slow Intelligent	Slow	Slow Dull	Very Dull	Totals
Light ...	128	284	215	97	41	14	779
Medium ...	162	345·5	302·5	124	49	16·5	999·5
Dark ...	62·5	186	153·5	70	23	11·5	506·5
Totals	352·5	815·5	671	291	113	42	2285

TABLE XXXIII.

Boys' Athletic Power.

Intellectual Grade.

Athletic Power.	Quick Intelligent	Intelligent	Slow Intelligent	Slow	Slow Dull	Very Dull	Totals
Athletic ...	159·5	421·75	355·5	158·75	40·5	12	1148
Non-Athletic	46	163·25	187·5	99·75	48·5	15	560
Totals	205·5	585	543	258·5	89	27	1708

TABLE XXXIV.

Girls' Athletic Power.

Intellectual Grade.

Athletic Power.	Quick Intelligent	Intelligent	Slow Intelligent	Slow	Slow Dull	Very Dull	Totals
Athletic ...	167·5	369·5	259·5	98·5	32	11	938
Non-Athletic	74·5	225·5	220·5	122·5	55	18	716
Totals	242	595	480	221	87	29	1654

TABLE XXXV.

Boys' Temper.

Intellectual Grade.

Temper.	Quick Intelligent	Intelligent	Slow Intelligent	Slow	Slow Dull	Very Dull	Totals
Quick ...	51	136·25	136·25	43	17·5	6	390
Good Natured	180	476·25	478·25	238	65·5	17·5	1455·5
Sullen ...	11	50	90·5	66	34·5	15·5	267·5
Totals	242	662·5	705	347	117·5	39	2113

TABLE XXXVI.

Girls' Temper.

Intellectual Grade.

		Quick Intelligent	Intelligent	Slow Intelligent	Slow	Slow Dull	Very Dull	Totals
Temper.	Quick ...	72·5	136·75	99·75	37·75	12	5·25	364
	Good Natured	206	464·25	444·25	171·25	63	22·75	1371·5
	Sullen ...	23·5	74	93·5	58	36	13·5	298·5
	Totals	302	675	637·5	267	111	41·5	2034

TABLE XXXVII.

Boys' Handwriting.

Intellectual Grade.

		Quick Intelligent	Intelligent	Slow Intelligent	Slow	Slow Dull	Very Dull	Totals
Handwriting Grade.	Very Good ...	35	57·5	32·5	14·5	6	—	145·5
	Good ...	103	237	196·5	71	20	4·5	632
	Moderate ...	67·5	240·75	280·25	120·75	51·25	19·5	780
	Poor ...	11	67·25	91	63·5	25·25	9·5	267·5
	Bad ...	2	7	27·25	13·75	2	3	55
	Very Bad ...	—	—	5	4	2	2	13
	Totals ...	218·5	609·5	632·5	287·5	106·5	38·5	1893

TABLE XXXVIII.

Girls' Handwriting.

Intellectual Grade.

		Quick Intelligent	Intelligent	Slow Intelligent	Slow	Slow Dull	Very Dull	Totals
Handwriting Grade.	Very Good ...	38	47	30	6	4	1	126
	Good ...	115	277	185	55·5	19	6	657·5
	Moderate ...	67	231·5	244·5	112·5	43	14	712·5
	Poor ...	26·5	62	75·5	48	21	11	244
	Bad ...	7	11	9	10	7	1	45
	Very Bad ...	2	2	4	1	4	3	16
	Totals ...	255·5	630·5	548	233	98	36	1801

TABLE XXXIX. *Alternative Psychical Characters in Boys.*

Intellectual Grade.

Psychical Characters.	Quick Intelligent	Intelligent	Slow Intelligent	Slow	Slow Dull	Very Dull	Totals
(*a*) Keen Conscientiousness	231·5	520·25	451	148·75	48·75	11·75	1412
Dull	26	132·75	252	171·75	80·25	25·25	688
Totals	257·5	653	703	320·5	129	37	2100
(*b*) Shy	142·5	385	415·5	190·25	74·75	22·5	1230·5
Self-Assertive	101	265·5	295	133·75	52·25	14	861·5
Totals	243·5	650·5	710·5	324	127	36·5	2092
(*c*) Self-Conscious ...	135·5	312	337·75	147·5	44·75	14	991·5
Unself-Conscious ...	113·5	325	331·75	180	90·75	21·5	1062·5
Totals	249	637	669·5	327·5	135·5	35·5	2054
(*d*) Noisy	92	265·5	265	131·75	56·25	15·5	826
Quiet	206·5	465·5	498·5	218·75	86·75	26	1502
Totals	298·5	731	763·5	350·5	143	41·5	2328
(*e*) Popular	216·5	548·5	513·75	222·25	69	18·5	1588·5
Unpopular	25	101·5	132·75	72·25	44	9	384·5
Totals	241·5	650	646·5	294·5	113	27·5	1973

TABLE XL. *Alternative Psychical Characters in Girls.*

Intellectual Grade.

Psychical Characters.	Quick Intelligent	Intelligent	Slow Intelligent	Slow	Slow Dull	Very Dull	Totals
(*a*) Keen Conscientiousness	252	579·5	390·5	132·5	35	11·5	1401
Dull	40·5	113·5	178	107·5	54	28·5	522
Totals	292·5	693	568·5	240	89	40	1923
(*b*) Shy	130·75	419·75	411	183·5	64	22·5	1231·5
Self-Assertive	138·75	252·75	176	70·5	37	17·5	692·5
Totals	269·5	672·5	587	254	101	40	1924
(*c*) Self-Conscious	133·5	337·5	282	129·5	52·5	20·5	955·5
Unself-Conscious ...	144·5	354·5	298	116·5	43·5	17·5	974·5
Totals	278	692	580	246	96	38	1930
(*d*) Noisy	124·25	255·5	186·75	82·5	34	15·5	698·5
Quiet	197·75	536·5	477·75	202·5	78	27	1519·5
Totals	322	792	664·5	285	112	42·5	2218
(*e*) Popular	253·5	496·75	443·25	150·5	53	12·5	1409·5
Unpopular	26·5	89·75	113·75	74	36	21·5	361·5
Totals	280	586·5	557	224·5	89	34	1771

ON THE RELATION BETWEEN THE SYMMETRY OF THE EGG AND THE SYMMETRY OF THE EMBRYO IN THE FROG (*RANA TEMPORARIA*).

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PART I.

As every embryologist will be aware, the relation between the first segmentation furrow of the frog's egg and the sagittal plane of the frog embryo has been both the source of a famous theory and the central point of an equally celebrated controversy. For while the supposed coincidence of the two planes led Roux directly to the experiment in which one of the first two blastomeres being killed a half embryo was produced from the survivor and so to the definite formulation of the preformationist doctrine of "Selbstdifferenzirung" and "Mosaikarbeit," the criticism which this theory called forth was soon directed to a re-examination, and eventually resulted in a denial of the facts on which the hypothesis was based.

Roux's own statement as to the relations between the planes in question, made in 1883, is sufficiently explicit. After describing the difficulties he had to encounter in obtaining an accurate measurement of the angle between the two, and giving the magnitudes of such measurements, unfortunately only a small number, as he was able to get, he concludes as follows: "So ist es wohl berechtigt wenn ich das hervorspringende Bestreben beider Ebenen zusammenfallen zu lassen, als das Gesetzmässige auffasse, und die gefundenen kleineren und grösseren Abweichungen nicht auf Abweichungen von dem Gesetz sondern auf die noch restirenden Fehlerquellen zurückfuhre und so das Gesetz aufstelle.—Mit der Ebene der ersten Furchung wird beim Froschei zugleich auch die künftige Medianebene des Individuums bestimmt und zwar fallen beide zusammen" (Roux, 1883, p. 109). Nor is the relation thus established one of mere coincidence, it is a causal relation, as we read in the *Mosaikarbeit,* published in 1893 (p. 850): "Das Prinzip der organbildende Keimbezirke beginnt somit erst mit der Furchung eine 'feste' Bedeutung zu erhalten; dieselbe ist nicht blos eine topographische, sondern auch eine causale," a conception which is of course a necessary part of the hypothesis of nuclear predetermination elaborated by Weismann out of Roux's *Mosaiktheorie.* Like many other of the facts upon which this theory is built, the universality at least of the coincidence of these two planes has been denied. Oscar Hertwig has stated—on the strength of observations made on eggs compressed between horizontal glass plates—that they may make any angle with one another. Schulze and Kopsch think it probable that they coincide in the majority of cases.

Not one of these authors has, however, thought it worth while to examine a large—a statistically intelligible—number of cases, though it would appear that the magnitude in question is obviously a variable one and preeminently amenable to such treatment. It is by this method therefore that I have sought for a solution of the problem.

In the meantime the centre of interest has shifted. The very numerous experiments that have been made on the behaviour of eggs segmenting under pressure and on the development of isolated blastomeres, have distinctly negatived the idea of the preexistence in the fertilized egg-cell of definite nuclear units for the determination of the inheritable characters of the organism, an idea which has now been abandoned by Roux himself, and less importance has come to be attached to segmentation as a mechanism for separating such units; more attention is now paid to the initial structure of the ovum, and the presence in it—demonstrated by recent research in some cases—of definite cytoplasmic organ-forming substances as a cause of differentiation.

In the frog's egg itself (*R. fusca*) Schulze has shown that though the symmetry of the unfertilized ovum is radial about the axis, a bilateral symmetry is acquired during fertilization by the formation of a crescentic band—at first grey, but afterwards white and added to the white area on the vegetative side of the egg—along the border of the pigmented area on one side. The grey crescent arises, according to Roux, by immigration of the pigment into the interior of the egg. Both Roux (1903) and Schulze agree that the point of entry of the sperm is in the plane of this bilateral symmetry, and on the side opposite to that on which the grey crescent appears; and Roux, following out his earlier idea of the causal connection between the sperm path and the first furrow, believes that it is the entry of the sperm that is responsible for the change of symmetry. It is further stated by both authors that the side of the grey crescent is postero-dorsal, since the dorsal lip of the blastopore is formed here. The plane of symmetry and the sagittal plane therefore tend to coincide.

Normally, according to Schulze, the first furrow also lies in this plane, but considerable deviations are possible, their frequency increasing with the length of time that the eggs have remained in the uterus before being laid.

Morgan has investigated the relation between these three planes in *R. temporaria* and *R. palustris*; the first furrow lies in the plane of symmetry in 24 °/₀ of the cases in the first species, in 50 °/₀ in the second, and when this occurs the sagittal plane coincides with both. But the first furrow may be at right angles to the plane of symmetry, and in that case the sagittal plane may coincide with either or be in between.

A complete treatment of the whole question demands therefore the determination of the position in each of a large number of eggs of the sperm-path, the plane of symmetry, the first furrow and the sagittal plane. This is, however, unfortunately impossible, since the sperm path disappears long before the appearance of the sagittal plane. It is possible, however, to determine either the first three or the last three in one and the same egg; and this I have attempted to do. In the first part of this paper I can only give the results of the measurement of the angles between the plane of symmetry, the first furrow and the sagittal plane in a fairly large number of cases. The relation between the sperm path and the first furrow involves the cutting of a large number of eggs into series of sections, and must be left till later.

The angle between the first furrow and the sagittal plane may be measured in various ways. The eggs may be fastened by the jelly to glass plates coated with paraffin and the direction of the planes marked, with the aid of a lens, by a needle on the wax. Or the eggs may be fastened direct to the underside of a glass plate and the directions marked with a paint-brush. These methods are, however, very inaccurate, and I have discarded all the measurements made in this and previous years in this way. They are inaccurate for two reasons. In the first place it is very difficult to place the marks accurately, and in the second, the sagittal plane has to be determined by the direction of the medullary folds or plate, a direction which is probably in many cases not the original direction of the median plane, for during the closure of the blastopore the eggs rotate not only about a horizontal axis but about a vertical axis as well, though of course to a less, and to an irregular extent.

It became necessary therefore to determine the sagittal plane by the position of the dorsal lip of the blastopore in an early stage before rotation has begun. To do this the egg must be viewed from the lower side. I made use of the following apparatus. The microscope was placed with the tube horizontal, and to the stage was attached a holder which carried a slide on which the eggs were placed, and below this a mirror at 45°. The eggs were illuminated from below. The slide was ruled with a diamond with parallel lines, and by means of the micrometer and goniometer with which the ocular was provided it was a simple matter to read off the angle between the first furrow and a line on the slide, and later on to determine the position of the sagittal plane in the same fashion.

The same method was used for the plane of symmetry.

One possible objection to this means of measurement is, I have satisfied myself, groundless. Between the first and the second measurements the eggs must be kept in a damp chamber, and it might be thought that in moving them to and fro, however carefully, some slight shifting might occur. I measured the first furrow in a set of eggs, then violently shook the slide and jogged it on the table, and then measured again. The difference in many cases, nearly half, was less than 3° and in no case very great*; and the eggs of course were never ordinarily subjected to such violent treatment. The eggs were always taken straight from the uterus, placed in rows on the slide, moistened with water, artificially fertilized, and allowed to remain in water until the jelly had become well swollen. They were then removed from the water and kept in a damp chamber till required.

The following are the results of the measurements.

The angle between the first furrow and the sagittal plane was determined in 889 cases, and in 397 of these the position of the plane of symmetry was also observed. In 14 other cases the angle between the plane of symmetry and the first furrow was found, in 112 other cases that between the plane of symmetry and the sagittal plane. There are thus 509 observations of the angle between the plane of symmetry and the sagittal plane, 411 observations of that between the plane of symmetry and the first furrow.

I. *First Furrow and Sagittal Plane.*

Table I. gives the frequencies for groups of 10°.

TABLE I.

First Furrow and Sagittal Plane.

Groups of 10°.

Class	Frequency	Class	Frequency
−90—81	27	+ 0—10	111
80—71	26	11—20	86
70—61	24	21—30	84
60—51	32	31—40	43
50—41	30	41—50	45
40—31	42	51—60	34
30—21	53	61—70	31
20—11	69	71—80	29
10—0	104	81—90	19
			889

$M = 2{\cdot}12^\circ \pm {\cdot}914$

$\sigma = 40{\cdot}39^\circ \pm {\cdot}646.$

---

* The actual frequencies of these differences were :

Angle :	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°...18°
Frequency :	6	10	8	5	9	5	2	1	1	4	1	1	2 ... 1

Fig. 1 is the corresponding frequency polygon.

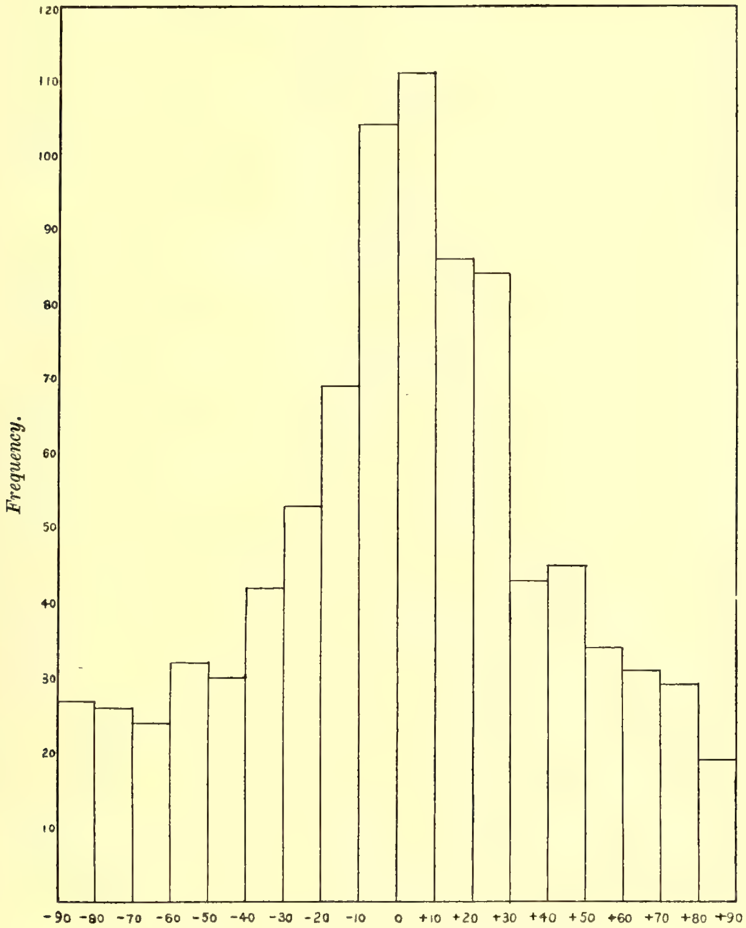


Fig. 1. First Furrow and Sagittal Plane.

It will be seen that there is a very decided tendency for the two planes to coincide. Still all deviations are possible and all occur, and occur pretty equally in either direction, for the polygon is fairly symmetrical.

This tendency towards coincidence might not unnaturally lead to the supposition that there is a causal connection between the two. The correlation table (Table II.) quite negatives this idea.

The table, which was constructed by taking in each egg the angle between the plane of symmetry and the first furrow and that between the plane of symmetry and the sagittal plane, shows clearly how small the correlation is; it works out at $\rho = \cdot 138 \pm \cdot 031$. Figs. 2 and 3, regression schemes constructed from the correlation table, emphasize the point. It will be noticed, however, that in Fig. 2 the regression line is rather sharply bent away from the horizontal on the

TABLE II.

Correlation between First Furrow and Sagittal Plane.

Plane of Symmetry and Sagittal Plane.

Plane of Symmetry and First Furrow.	90		−			0			+			90	Totals	Means
90	1	—	4	5	1	8	9	1	1	—	1	1	32	− 1·4
	—	1	—	3	3	6	5	1	—	1	—	—	20	− ·6
−	—	3	1	—	4	6	3	1	2	—	1	2	23	− ·11
	—	—	—	2	2	4	6	1	—	1	1	—	17	+ ·14
	—	1	—	1	7	4	5	3	3	3	—	—	27	+ ·2
	—	—	1	3	8	24	21	14	7	4	—	3	85	+ ·5
0	1	1	2	3	8	15	15	11	3	1	1	2	63	+ ·1
	—	—	—	—	3	6	6	4	4	—	—	1	24	+ ·7
	—	—	—	3	5	5	2	3	1	—	2	1	22	+ ·7
+	—	—	1	—	1	8	3	5	3	—	2	—	23	+ ·7
	—	—	—	1	1	4	5	—	3	—	2	—	16	+ ·8
90	—	1	1	4	5	9	12	5	2	3	2	1	45	+ ·21
Totals	2	7	10	25	48	99	92	49	29	13	12	11	397	
Means	− 2·5	− 1·5	− 1·6	− ·54	+ ·08	+ ·04	+ ·05	+ ·7	+ ·8	+ ·26	− ·06	− ·32		

$\rho = \cdot 138 \pm \cdot 031.$

Plane of Symmetry and Sagittal Plane.

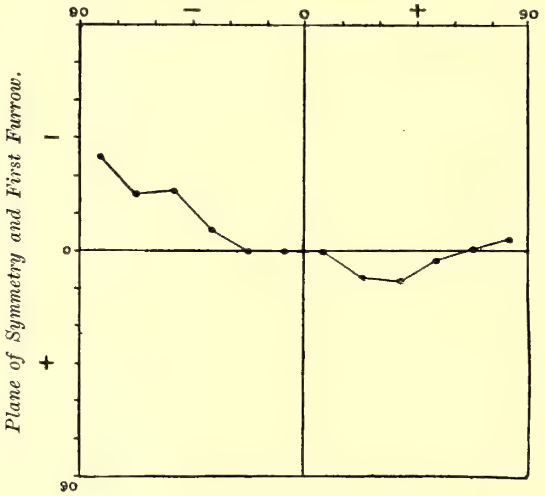
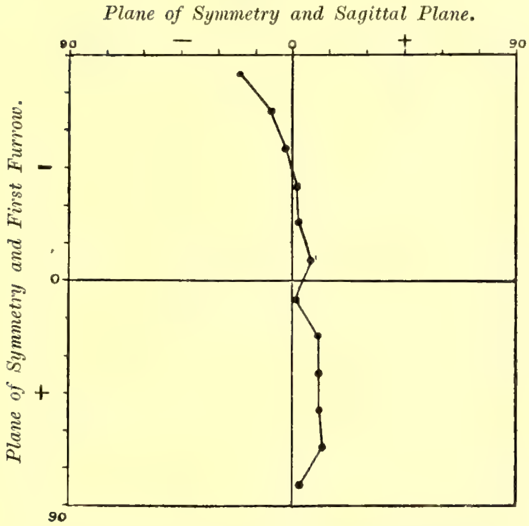


Fig. 2.



FIGS. 2 and 3. Schemes of Regression constructed from Table II.

In Fig. 2 the dots indicate the mean value of the angle between Plane of Symmetry and First Furrow for each class of angle between Plane of Symmetry and Sagittal Plane, in Fig. 3 the converse.

left-hand side. As we shall see presently, and as indeed may be gathered from Table II., this is due to the tendency of the first furrow to lie either in *or at right angles to* the plane of symmetry, and Professor Pearson has suggested to me that if the upper and lower arrays of the table were omitted the value of ρ would be still further reduced. This is, as a matter of fact, the case.

Table III. is the correlation table constructed from the six middle arrays of Table II.; Fig. 4 the corresponding regression scheme. The line of regression is now practically horizontal, and the value of ρ—less than the probable error—practically *nil.*

TABLE III.

Correlation table constructed from the Middle Strip of Arrays of Table II.

Plane of Symmetry and Sagittal Plane.

Plane of Symmetry and First Furrow.	90			–			0			+		90		Totals
45	—	—	—	2	2	4	6	1	—	1	1	—	45	17
–	—	1	—	1	7	4	5	3	3	3	—	—		27
	—	—	1	3	8	24	21	14	7	4	—	3		85
0													0	
	1	1	2	3	8	15	15	11	3	1	1	2		63
+	—	—	—	—	3	6	6	4	4	—	—	1		24
45	—	—	—	3	5	5	2	3	1	—	2	1	45	22
	90						0					90		
Totals	1	2	3	12	33	58	55	36	18	9	4	7		238
Means	+·5	–·5	+·1	+·08	+·04	+·01	–·21	+·13	+·11	–·9	+·7	+·5		

$\rho = \cdot 009 \pm \cdot 044.$

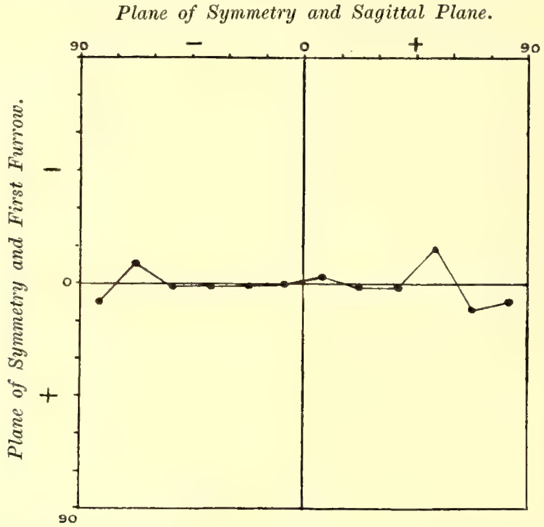


FIG. 4. Regression Scheme constructed from Table III. The dots mark mean values of the angle between Plane of Symmetry and First Furrow.

In short, between the first furrow and the sagittal plane in the frog's egg there is no correlation, or—if the correlation table is an expression of that canon of induction known as the method of concomitant variations—no causal connection.

The two planes coincide in so many cases merely because each, as we shall see, and particularly the sagittal plane, tends to lie in the plane of symmetry. Beyond that there is no connection between them. The symmetry of segmentation and the symmetry of the embryo are independent, and in this case at least the truth of Driesch's famous aphorism is vindicated—"Furchungsmosaik braucht kein Mosaik der Potenzen zu sein."

II. *Plane of Symmetry and Sagittal Plane.*

The number of observations is here not so great, but still great enough to produce a symmetrical result (Table IV., Fig. 5). It will be seen that the tendency of these two planes to coincide is more considerable, the standard deviation being smaller than in the case of the first furrow and the sagittal plane.

TABLE IV. *Plane of Symmetry and Sagittal Plane.*

Groups of 10°.

Class	Frequency	Class	Frequency
−90—81	4	+ 0—10	91
80—71	6	11—20	52
70—61	3	21—30	42
60—51	8	31—40	27
50—41	14	41—50	15
40—31	23	51—60	7
30—21	29	61—70	11
20—11	60	71—80	6
10—0	103	81—90	8
			509

$M = 2{\cdot}23° \pm {\cdot}889$

$\sigma = 29{\cdot}75° \pm {\cdot}629.$

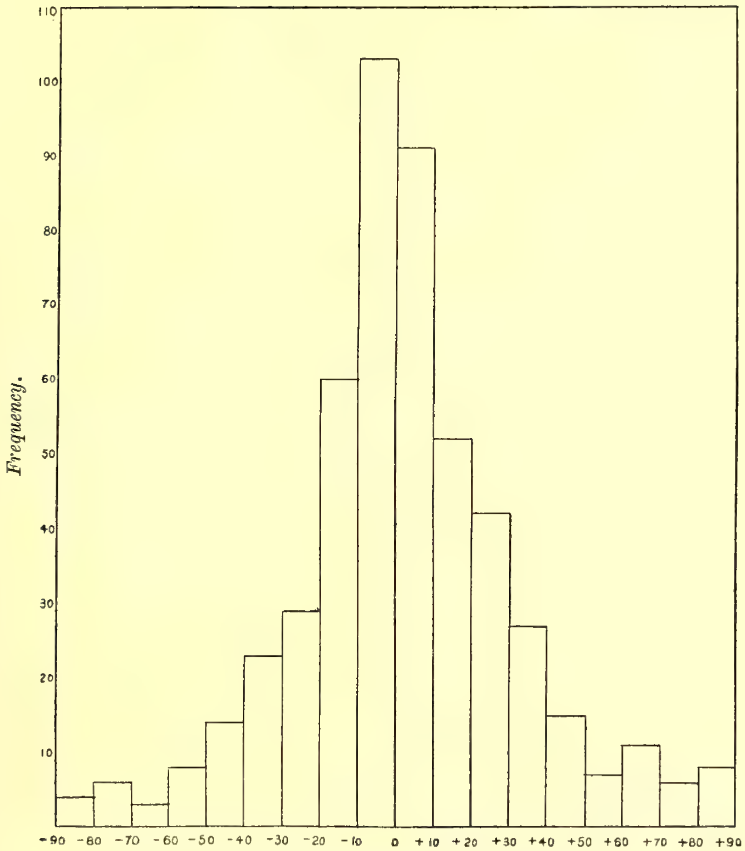


FIG. 5. Plane of Symmetry and Sagittal Plane.

TABLE V. *Correlation between Plane of Symmetry and Sagittal Plane.*

First Furrow and Sagittal Plane.

First Furrow and Plane of Symmetry.	90		−				0			+		90	Totals
90	8	—	1	—	1	2	—	2	4	4	4	6	32
	—	—	1	—	—	1	—	2	2	3	9	2	20
+	1	—	2	1	2	1	1	1	5	5	2	2	23
	1	—	—	—	—	1	2	5	5	2	—	1	17
	—	—	—	1	—	5	4	7	2	4	4	—	27
	1	—	1	3	4	20	25	14	9	4	2	2	85
0	2	1	3	5	9	15	11	13	1	—	2	1	63
	—	—	1	4	6	7	4	1	—	1	—	—	24
	1	5	3	6	1	2	1	2	1	—	—	—	22
−	—	4	7	3	5	—	3	—	—	—	1	—	23
	1	6	3	2	1	1	1	—	—	—	—	1	16
90	14	4	3	2	1	3	—	1	—	4	5	8	45
Totals	29	20	25	27	30	58	52	48	29	27	29	23	397
Means	−1·0	−3·8	−1·9	−1·7	−·9	−·18	−·03	+·72	+2·2	+1·6	+1·6	+·16	

$\rho = \cdot372 \pm \cdot025.$

The correlation table (Table V.), constructed by taking the first furrow as a fixed line and correlating the angles made with it by the sagittal plane and the plane of symmetry, and the regression scheme (Fig. 6) bring out the result in another way.

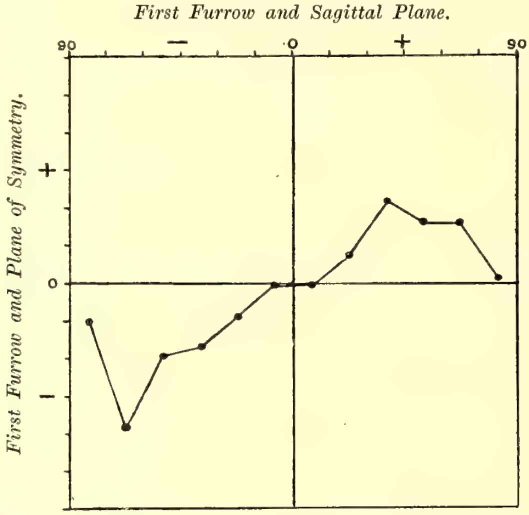


Fig. 6. Regression Scheme of the mean values of angles between First Furrow and Plane of Symmetry for each class of angle between First Furrow and Sagittal Plane. Constructed from Table V.

The correlation is obviously spoilt by those cases in which the first furrow is at right angles to the plane of symmetry; but by taking the 36 central squares of the table only (Table VI. and Fig. 7), the value of ρ may be increased to ·439 ± ·032. By taking the six middle arrays only, it may be increased still further to ·477 ± ·028.

TABLE VI.

Constructed from the 36 Central Squares of Table V.

First Furrow and Sagittal Plane.

First Furrow and Plane of Symmetry.	45 −	−	− 0	0 +	+	+ 45	Totals
45	—	—	1	2	5	5	13
+	1	—	5	4	7	2	19
0	3	4	20	25	14	9	75
0	5	9	15	11	13	1	54
−	4	6	7	4	1	—	22
45	6	1	2	1	2	1	13
Totals	19	20	50	47	42	18	196
Means	−1·0	−·7	−·06	+·21	+·41	+·9	

$\rho = ·439 \pm ·032$.

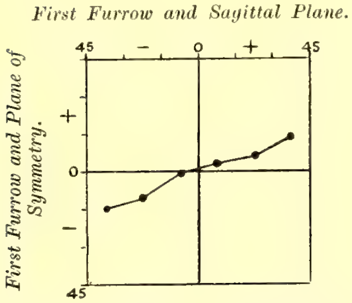


Fig. 7. Regression Scheme constructed from Table VI. The dots have the same significance as in Fig. 6.

III. *Plane of Symmetry and First Furrow.*

As Table VII. shows, the first furrow tends to lie either in or at right angles to the plane of symmetry, though the former predominates. In Fig. 8 I have accordingly divided the frequency polygon into two parts, one distributed about 0°, the other about 90°. This alternative of two "predilection" directions, to borrow a phrase of Roux's, for the first furrow to choose from, completely throws out the correlation (Table VIII. and Fig. 10); but if the range from −45° to +45° only be considered (Table IX.) the value of ρ rises to ·271 ± ·038. In the "scatter" diagram (Fig. 9), in which each instance is separately recorded, the coincidence of the two planes is very well shown by the crowding of the dots along the diagonal.

TABLE VII.

Plane of Symmetry and First Furrow.

Groups of 10°.

Variation about 0°.

Class	Frequency
−45— 36	8
35— 26	17
25— 16	21
15— 6	26
5—+ 5	98
+ 6— 15	26
16— 25	16
26— 35	18
36— 45	13
	243

Variation about 90°.

Class	Frequency
+46— 55	17
56— 65	14
66— 75	13
76— 85	17
86—−86	44
−85— 76	23
75— 66	9
65— 56	15
55— 46	16
	168

Variation about 0°

$M = \cdot 53^\circ \pm \cdot 853$

$\sigma = 18 \cdot 70^\circ \pm \cdot 603$

Variation about 90°

$M = 90 \cdot 17^\circ \pm 1 \cdot 212$

$\sigma = 23 \cdot 29^\circ \pm \cdot 857.$

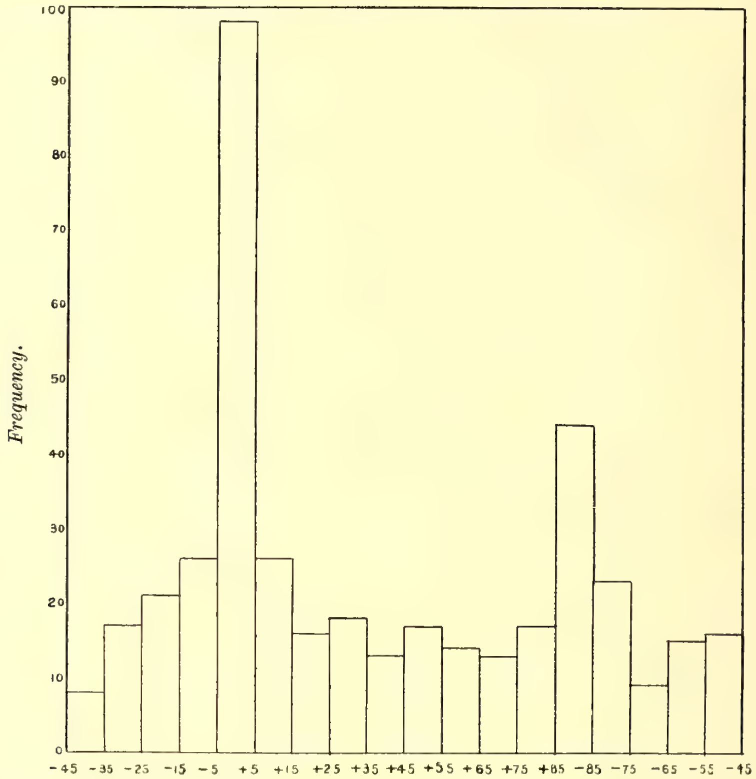


Fig. 8. Plane of Symmetry and First Furrow.

TABLE VIII.

Correlation between Plane of Symmetry and First Furrow.

First Furrow and Sagittal Plane.

Plane of Symmetry and Sagittal Plane.	90		−				0		+			90	Totals
	1	—	—	—	—	1	—	—	—	—	—	—	2
−	1	—	—	1	2	2	—	1	—	—	—	—	7
	—	1	2	—	—	—	1	2	2	1	1	—	10
	1	2	2	4	—	2	1	2	3	6	1	1	25
	1	4	3	6	8	8	4	2	4	3	4	1	48
	2	7	6	5	9	26	10	6	3	5	9	11	99
0												0	
	17	3	5	4	2	9	26	9	5	2	6	4	92
	1	3	2	2	4	5	2	20	5	3	—	2	49
+	2	—	2	2	3	—	5	4	5	4	1	1	29
	1	—	1	2	1	—	—	—	1	2	5	—	13
	1	—	1	—	1	3	3	2	—	—	1	—	12
	1	—	1	1	—	2	—	—	1	1	1	3	11
	90						0					90	
Totals	29	20	25	27	30	58	52	48	29	27	29	23	397
Means	+ ·4	− ·6	+ ·18	− ·13	− ·1	− ·14	+ ·4	+ ·6	+ ·32	+ ·09	+ ·5	+ ·6	

$\rho = \cdot 087 \pm \cdot 032.$

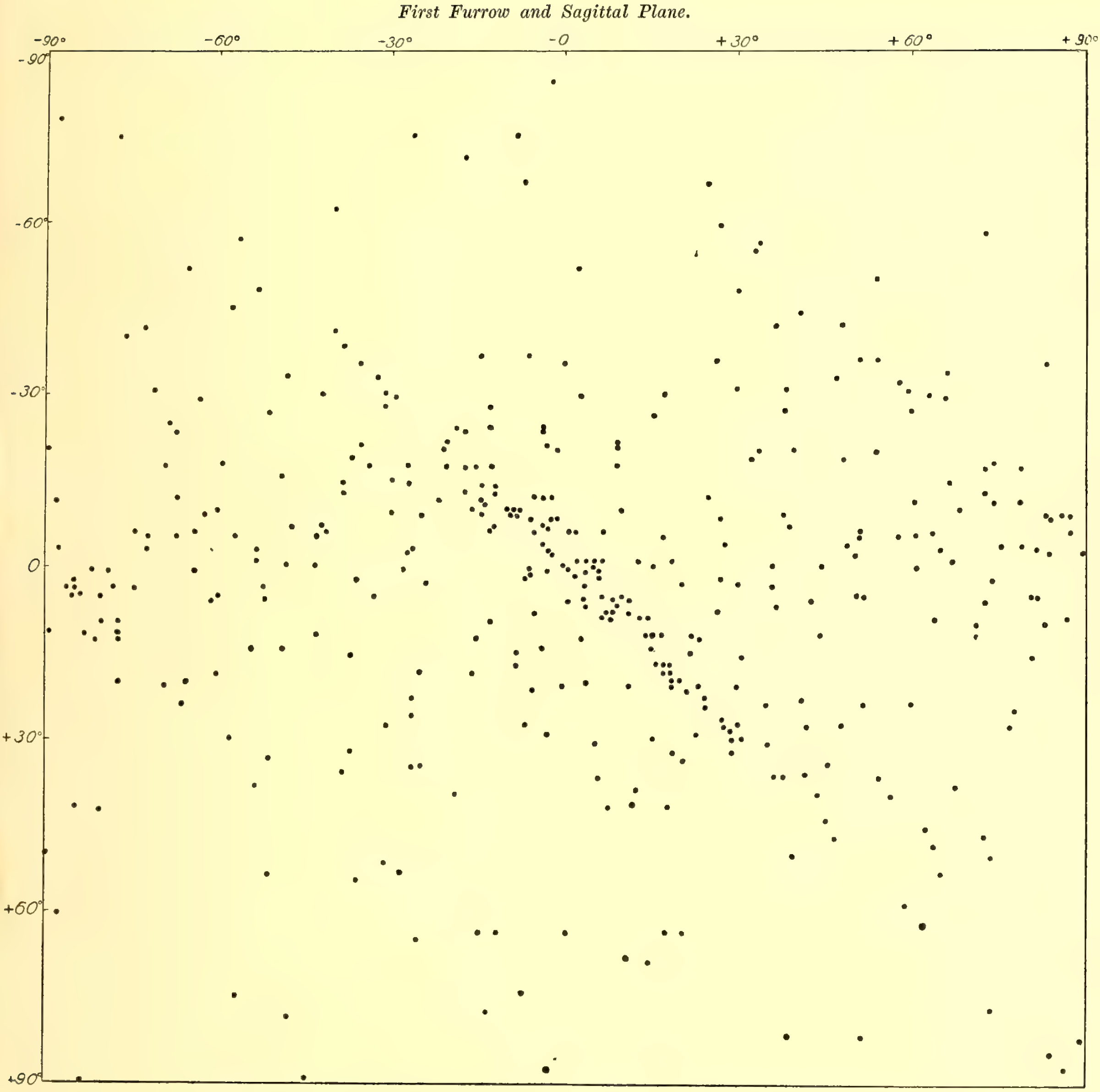


FIG. 9. 'Scatter' Diagram of the Correlation between the Plane of Symmetry and the First Furrow.

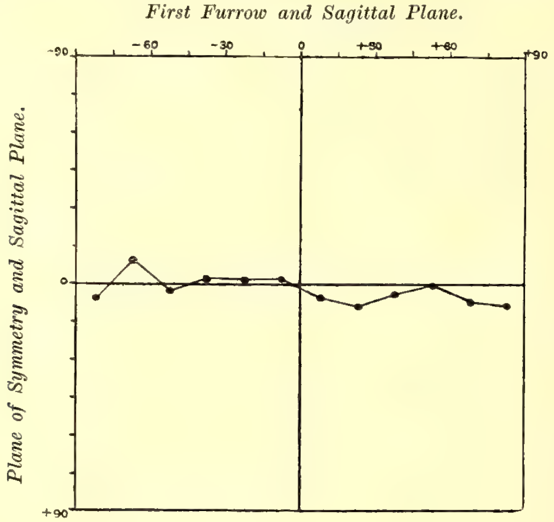


Fig. 10. Regression Scheme constructed from Table VIII. The dots are the means of the angles between Plane of Symmetry and Sagittal Plane for each class of angle between First Furrow and Sagittal Plane.

TABLE IX.

Constructed from the Central Squares of Table VIII.

First Furrow and Sagittal Plane.

Plane of Symmetry and Sagittal Plane.	45	−		o	+	45	Totals
−	4	—	2	1	2	3	12
	6	8	8	4	2	4	32
	5	9	26	10	6	3	59
+	4	2	9	26	9	5	55
	2	4	5	2	20	5	38
	2	3	—	5	4	5	19
Totals	23	26	50	48	43	25	215

$\rho = \cdot 271 \pm \cdot 038.$

The examination, therefore, of a fairly large number of instances

(1) supports the statement that the first furrow and the sagittal plane tend to coincide, though deviations of any magnitude are possible;

(2) but contradicts the supposition that there is any causal nexus between the two;

(3) shows that the symmetry of the egg has a marked effect upon the symmetry of the embryo and upon the symmetry of segmentation. The effect, however, is not the same in the two cases.

A question that of course will obviously occur is, to what are the deviations from coincidence due? They may be the result of internal or external factors, and of the latter heat and light and gravity at once suggest themselves as possible. Many years ago Pflüger showed that, by preventing the jelly from absorbing water, the egg of the frog could be prevented from rotating inside it and compelled to remain in any arbitrarily selected position. The first and second furrows were, however, shown to be vertical, the third horizontal as in the normal egg. The median plane of the embryo was determined by the plane which included the original, now tilted, egg-axis and the present vertical axis, a plane afterwards termed by Born, who examined the internal structure of eggs so placed in "Zwangslage," the "streaming meridian," since there occurred equally on each side of it an upward streaming of cytoplasm and pigment, a downward sinking of the heavy yolk granules. The first furrow, according to Pflüger, in such inverted eggs may make any angle with this plane; according to Born, it is generally either in or at right angles to it, and Roux corroborates this.

It is evident that under the influence of gravity a very marked bilateral arrangement is conferred upon the constituents of the egg and that this symmetry impresses itself on segmentation and embryonic development, and it does not seem impossible that, before the fertilized egg, which is laid with its axis in any position, is able to rotate inside its jelly membranes, a slight bilateral symmetry may be conferred upon it under the influence of gravity, and that this may interfere with the other bilaterality produced by the entrance of the sperm.

I attempted to measure the angle between the original position of the egg (before rotation), the plane of symmetry and the first furrow; but the measurements are, I am afraid, too few and too inconclusive. I give here, however (Fig. 11), a curve of the angles made by the first furrow with the streaming meridian (gravitation symmetry plane) of a number of eggs kept in "Zwangslage." If the measurements are not too few (215) to be trusted, the curve brings out the very interesting point that the first furrow tends to lie either in, or at right angles

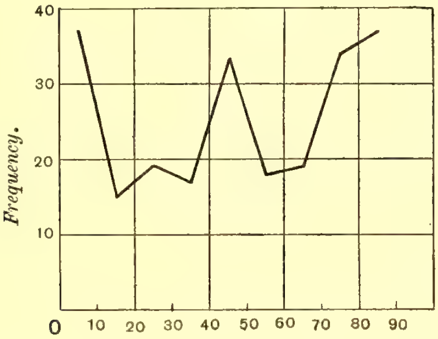


FIG. 11. The First Furrow and the 'Gravitation Symmetry Plane.'

to, or at 45° to the plane of symmetry, as though equally strong attractions were exerted by the two "predilection" planes, to use Roux's expression, upon the nuclear spindles.

I have also made a few experiments (447 eggs) on the influence of heat and light upon the direction of the sagittal plane. The eggs were placed, as before, on slides ruled with parallel lines, in a damp chamber lined and covered with black cloth. They were then exposed continuously to the light and heat of an incandescent burner placed 15 inches away. As the curve (Fig. 12) shows, there seems to be a slight tendency for the sagittal plane to be diverted into either the direction of the incidence of light or a direction at right angles to it. The observations are so few, and the tendency so slight, that I cannot lay especial stress upon the result, and publish it with all reserve. Further experiments with heat only, or light only, and light of various colours will perhaps make a more positive conclusion possible.

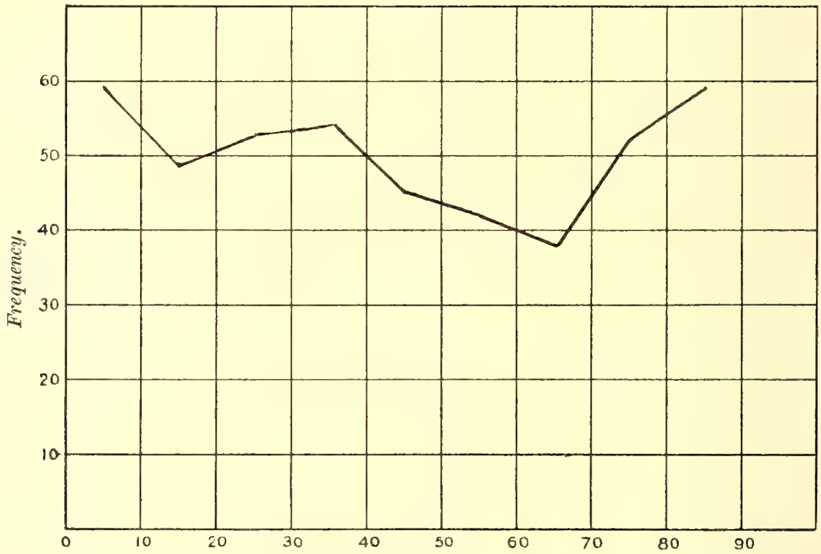


FIG. 12. Angle between direction of Light and the Sagittal Plane.

The curves of Figs. 1, 5 and 8 are not and cannot be reduced to normal curves. I have drawn the appropriate normal curves on the top of these polygons and there is a complete absence of fit. The apex of the polygon in each case projects a good way above the apex of the probability curve, while the ends of the latter lie outside the ends of the polygon.

The latter is very probably due to the fact that the limitation of the range of variability to 90° on each side is an artificial one. It is extremely likely that deviations slightly greater than 90° occur in small numbers, but that these have been—in actual observation—included as large deviations on the opposite side of the curve*.

In the case of the angle between the first furrow and either the sagittal plane or the plane of symmetry, this is unavoidable, since the two ends of the furrow are, externally, alike; but it would be possible—I am sorry to say I neglected to do this—to distinguish between deviations which are 180° apart and of opposite sign in the case of the plane of symmetry and the sagittal plane, since each of these is polarized, there being a larger extent of unpigmented yolk at one end of the plane of symmetry than at the other, and the sagittal plane being marked, at one end only, by the dorsal lip of the blastopore.

Indirectly, it is true, the two ends of the first furrow might be distinguished from one another by the position of the furrow on the bilaterally symmetrical unpigmented yolk area; but at the large deviations in question—about 90°—this would hardly be practicable.

With regard to the first point of difference between the frequency polygons and the normal curves, Professor Pearson suggested to me that the discrepancy might possibly be due

(1) to a tendency of the planes not only to coincide, but to lie at 180° with one another, the two positions being indistinguishable in observation;

(2) to the existence of two kinds of eggs, one in which the planes practically always coincide, another in which they deviate one from another at random.

The first supposition is untenable.

As Schulze and Roux have pointed out, the dorsal lip always appears on one side of the egg, at one end of the plane of symmetry, namely on the side of the grey crescent, where the unpigmented area extends most nearly to the equator. With regard to the first furrow there is, externally, no difference between its ends; the only internal difference is in the position in it of the male and female pronuclei, which lie a little away from, but on opposite sides of, the axis. One end of the plane of the first furrow might therefore be termed male, the other female. The male pronucleus must lie on that side of the egg on which the spermatozoon has entered, and this is always (Schulze and Roux) on the side opposite to the grey crescent. This plane could not, therefore, under any circumstances, deviate by both 0° and as much as 180° from either the plane of symmetry or the sagittal plane.

With regard to the second proposed explanation.

In Table X. will be found the parentage of the eggs used in the several experiments, with the date of each.

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* Professor Pearson obtained general formulae for fitting normal curves to the observations, by supposing the extremities of such normal curves beyond 90° cut off, reversed and added to the frequency on the opposite side; but even so the observations failed to fit the normal curve modified in this manner.

TABLE X.

Table showing the dates of the Several Experiments and the Parentages of the eggs used in each.

Experiment	Date	Parentage	
A	30 iii. 06	one ♂ one ♀	
B	31 iii. 06	one ♂	one ♀
C	,, ,,		
D	,, ,,	one ♂	
E	,, ,,	one ♂	
F	1 iv. 06	one ♂ one ♀	
G	,, ,,		
H	2 iv. 06	one ♂ one ♀	
H′	,, ,,		
K	3 iv. 06	one ♂	one ♀.
J	,, ,,	one ♂	
I	,, ,,		
N	,, ,,	one ♂	
O	,, ,,		

In Tables XI.—XIII. the frequencies in the individual experiments of each class of angle are set forth.

(*α*) With regard to the First Furrow and the Sagittal Plane (Table XI.).

It is evident that in some experiments (*A*, *F*, *G*, *H*, *I*, *N*, *O*) the two planes tend to coincide, while in the remainder the distribution is almost at random.

This difference is, however, clearly not due to the length of time the eggs remained in the uterus, for *A* and *O*, for example, are respectively at the beginning

TABLE XI.

First Furrow and Sagittal Plane.

Frequencies in the Individual Experiments.

Experiment	Frequencies																	
A	2	3	2	1	2	4	5	8	6	15	6	8	3	4	1	1	1	—
B	1	2	1	3	3	4	3	5	4	4	5	4	5	2	2	3	2	1
C	3	4	5	8	3	3	2	2	1	5	2	3	5	2	8	1	4	—
D	5	2	2	—	1	1	—	2	—	1	1	—	—	3	—	1	2	3
E	1	4	5	5	4	3	2	4	5	2	2	4	4	5	5	9	6	3
F	2	1	1	—	1	1	3	7	7	16	6	7	1	1	1	—	—	—
G	1	1	—	—	—	1	—	3	4	6	5	4	3	2	—	1	—	2
H	1	4	—	1	—	3	2	9	6	15	12	3	4	2	2	1	3	1
K	7	4	2	3	5	2	5	1	6	5	3	3	2	5	5	4	3	7
J	—	—	2	4	1	8	4	5	3	3	5	8	2	9	1	3	—	—
I	—	1	1	1	—	—	6	3	13	3	8	2	1	—	—	3	1	—
N	2	—	1	2	5	4	7	9	13	10	8	5	4	4	2	2	3	—
O	1	—	1	1	—	2	8	3	7	7	7	13	4	1	3	—	2	2

90 80 70 60 50 40 30 20 10 0 10 20 30 40 50 60 70 80 90

− +

and end of the series. Nor is it due to any peculiarity of the ova or spermatozoa. *B*, *C*, *D* and *E*, it is true, were all obtained from the same female, though not all fertilized by the same male; *F* and *G* were also produced by the same parents, and so were *N* and *O*, but in *J* the distribution is a random one: in *I* it is very strongly gathered about 0°, though in these two cases ova from one female were fertilized by spermatozoa from one male.

(β) The Plane of Symmetry and the First Furrow (Table XII.).

In *B*, *C*, *G*, *H*, *I* and *J* the frequency is greatest about 0°; in *D* and *K* the frequency about 90° rather exceeds that about 0°; in *E* the variation is a random one.

TABLE XII.

Plane of Symmetry and First Furrow.

Frequencies in the Individual Experiments.

Experiment	Frequencies																	
B	4	—	2	4	2	4	1	3	6	12	3	3	3	—	1	—	—	5
C	3	1	—	4	2	2	3	3	5	12	2	1	—	2	1	3	—	3
D	6	1	—	—	—	1	—	—	1	4	—	—	1	—	2	1	—	6
E	3	2	6	4	2	2	3	4	5	5	2	3	3	7	4	4	3	3
G	1	—	1	—	2	1	—	1	8	4	1	1	—	—	3	—	—	3
H	2	3	1	—	1	3	5	3	17	14	2	5	2	—	—	2	—	3
K	5	6	2	3	2	2	2	5	3	8	5	3	3	3	4	1	3	11
J	2	2	3	—	—	—	1	3	10	5	1	3	3	1	2	2	3	2
I	1	—	1	—	—	—	—	3	4	3	1	1	—	1	—	—	—	1

90 80 70 60 50 40 30 20 10 0 10 20 30 40 50 60 70 80 90

– +

It is clearly impossible to suppose that these differences are due to any peculiarity in the eggs, or spermatozoa produced by individual parents.

(γ) In the case of the Plane of Symmetry and the Sagittal Plane the tendency towards coincidence is shown in every experiment (Table XIII.).

TABLE XIII.

Plane of Symmetry and Sagittal Plane.

Frequencies in the Individual Experiments.

Experiment	Frequencies																	
B	—	1	—	1	1	5	4	8	7	4	2	2	3	5	4	2	1	3
C	—	2	—	3	—	3	1	7	9	9	4	8	1	1	—	—	2	—
D	1	—	—	—	3	1	2	10	10	15	12	2	2	—	—	1	—	—
E	—	1	—	1	3	4	4	5	17	12	4	3	3	2	—	2	—	3
G	1	—	—	1	2	1	2	3	11	13	4	10	4	1	—	2	—	—
H	—	—	—	1	1	2	5	11	10	21	7	6	5	2	—	1	1	—
H′	—	1	—	—	1	3	—	6	8	7	3	1	—	—	—	—	—	—
K	1	1	2	1	1	3	5	5	15	9	11	1	3	3	2	2	1	1
J	—	—	—	—	—	1	3	4	6	4	2	6	3	1	1	—	—	—
I	1	1	—	—	—	—	1	1	4	3	1	1	2	—	—	—	—	—

90 80 70 60 50 40 30 20 10 0 10 20 30 40 50 60 70 80 90

Although, therefore, the differences in distribution observed in the different experiments may, in the case of the first furrow and sagittal plane, and the plane of symmetry and the first furrow, be possibly applied, as Professor Pearson has suggested, to the explanation of the discrepancy between the observed polygon and the corresponding normal curve, such an explanation will hardly hold good in the case of the plane of symmetry and the sagittal plane.

I may add here that my results do not seem to lend support to Morgan's statement that, when the first furrow lies *in* the plane of symmetry, the sagittal plane coincides with both.

This position of the first furrow occurs in my experiments *B*, *C*, *G*, *H*, *I* and *J*; but in *G*, *H* and *I* the distribution of the angle between the first furrow and the sagittal plane is markedly crowded about 0°, in *B*, *C* and *J* it is random.

Further, in the "scatter" diagram (Fig. 9) of the correlation between the plane of symmetry and the first furrow, the dots which signify coincidence of the two are of course those which lie pretty thickly ranged along the diagonal. On Morgan's view all these dots should lie in the centre of the table: it is plain that they do not*.

In conclusion, I have to express my thanks to Mr E. H. J. Schuster for the generous loan of his calculator, and to Professor Pearson for the suggestions he has been good enough to make.

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* It should be pointed out however that the tendency of the sagittal plane to lie in the plane of symmetry does increase slightly as the angle between the first furrow and the plane of symmetry diminishes.

Thus the value of the standard deviation for the angle between plane of symmetry and sagittal plane for all the cases (Table IV.) is

$$\sigma = 29{\cdot}75^\circ \pm {\cdot}63 \quad (n = 509,\ M = 2{\cdot}23^\circ \pm {\cdot}89).$$

For the 397 cases where the first furrow is also known (Table II.)

$$\sigma = 30{\cdot}16^\circ \pm {\cdot}72 \quad (n = 397,\ M = 3{\cdot}41^\circ \pm 1{\cdot}02).$$

But if those cases only are considered in which the angle between first furrow and plane of symmetry is not greater than 45° (as in Table III.), then

$$\sigma = 28{\cdot}41^\circ \pm {\cdot}87 \quad (n = 238,\ M = 5{\cdot}10^\circ \pm 1{\cdot}24).$$

By taking the two middle arrays only of Table III.—those cases in which the said angle is not greater than 15°—

$$\sigma = 27{\cdot}94^\circ \pm 1{\cdot}09 \quad (n = 148,\ M = 5{\cdot}16^\circ \pm 1{\cdot}55);$$

while when the range of the difference between first furrow and plane of symmetry is restricted to 5° (by taking the diagonal strip of Fig. 9),

$$\sigma = 27{\cdot}46^\circ \pm 1{\cdot}32 \quad (n = 98,\ M = 4{\cdot}84^\circ \pm 1{\cdot}87).$$

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MISCELLANEA.

I. A Rejoinder to Professor Kapteyn.

By KARL PEARSON, F.R.S.

In the *Recueil des Travaux botaniques Néerlandais*, No. 3, 1905, will be found a reply to my recent criticism of Professor Kapteyn's theory of skew curves*.

Professor Kapteyn's reply consists, as far as I am able to follow it, of two statements accompanied by a complete ignoration of the criticisms I have made on his treatment of skew variation.

His statements are

(*a*) That he has arrived at a more general proof of the equation

$$y = \frac{h}{\sqrt{\pi}} F'(x)\, e^{-h^2[F(x)-M]^2} \quad \text{..(i)}$$

than Professor Edgeworth had previously done and that I have misrepresented his method of obtaining this equation.

(*b*) That I have largely profited by his theory and in fact adopted it as the basis of my own treatment.

I wish to consider briefly these two points.

(*a*) ydx is an elementary frequency and Kapteyn's equation can be written at once:

$$y\,\delta x = \frac{h}{\sqrt{\pi}} e^{-h^2(F(x)-M)^2} d(F(x)-M)$$

$$= \frac{h}{\sqrt{\pi}} e^{-h^2 z^2} dz$$

if z be put for $F(x) - M$.

Thus whatever Kapteyn's process of deduction may be, its final result is absolutely no more than asserting that some quantity z obeys the normal law and x the observed variable is a function of this "shadow" variable z. The process is completely the same in result as stretching a normal curve with varying degrees of stretch parallel to its base.

It is perfectly true that Professor Kapteyn only reaches this result after fifteen pages of preliminary talk, but the mathematical demonstration of (i) occupies something less than a page, and it involves nothing more than the assumptions made by Professor Edgeworth (see Kapteyn, p. 16). The normal curve is actually assumed on p. 16, and the validity of the assumption is just as large or small as the weight we choose to give to the three Gaussian conditions by which the normal curve is usually supported.

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* *Biometrika*, Vol. IV. pp. 199—203.

Further, when the assumptions have been made what is the result? Why, we are not really a bit forwarder than on the simple assumption that the general frequency-curve is:

$$y = \phi(x) \quad\text{..............................}(ii),$$

where $\phi(x)$ is perfectly arbitrary. *Both* (i) *and* (ii) *involve an arbitrary function and therefore can be made to give the most general frequency distribution which is conceivable!* I pointed this out years ago in criticising Professor Edgeworth's solution*.

Mathematically Kapteyn and Edgeworth seem to me to follow entirely the same path. But biologically there is a very serious flaw in Kapteyn's preliminary reasoning. He asserts that "the frequency-curve is generated under the influence of causes the effect of which is proportional to $\frac{1}{F'(x)}$" (p. 16). No causes that we are aware of in biological or indeed sociological investigations lead to a mathematical relationship of this kind. The relationships, which actually arise between the characters and between characters and environments, are not causative, but *correlational*, and this is a fundamental distinction which Kapteyn entirely overlooks.

Accordingly I personally am unable to see any real distinction between Kapteyn and Edgeworth. They both obtain a form of equation which is no more nor less general than $y = \phi(x)$, but it is put into a form which enables them to prostrate themselves before the Gaussian fetish.

(*b*) Professor Kapteyn asserts that in propounding as a general form of frequency-curve the equation

$$\frac{1}{y}\frac{dy}{dx} = \frac{x+a}{f(x)} \quad\text{..............................}(iii)$$

I am simply adopting the general differential equation of his curve (i). I am afraid I should look upon it as nothing more than stating in a convenient form the general result $y = \phi(x)$, for it contains the perfectly arbitrary function $f(x)$. There is nothing more in it than this, and I should not value in the least the discovery that (iii) was the general form of frequency-curve! But if (iii) really embraces Professor Kapteyn's curve and he wishes to claim priority for this find, I have only to say that I can give him, if he desires it, conclusive evidence that (iii) has been habitually discussed in my lectures on statistics for at least five or six years, if not longer!

My custom has been to follow exactly the lines indicated in my memoir on Skew Correlation†. Namely, to give (iii) and then assume that $f(x)$ could be expanded in the form $f(x) = S(c_n x^n)$. I then determine the values of the constants c_n by a finite difference-equation between the moments.

The Drapers' Memoir referred to above was only published in 1905, but if Professor Kapteyn looks at *Biometrika*, Vol. II. p. 281, issued in June, 1903, he will see the general formula(e) for c_n in terms of the moments given, and this was at a time anterior to my knowledge of Professor Kapteyn's paper.

In the question of an important discovery, priority by the usual scientific courtesy turns on priority of publication.

Professor Kapteyn's memoir is dated October, 1903. My formula was published in June, 1903, showing that I was then using the expression:

$$\frac{1}{y}\frac{dy}{dx} = \frac{x+a}{f(x)} \quad\text{..............................}(iii).$$

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* *Phil. Mag.*, Jan. 1901, p. 111.

† *Drapers' Research Memoirs, Biometric Series* II. Dulau and Co.

In my opinion, however, there is absolutely no important discovery here, Kapteyn's or rather Edgeworth's (i) and my (iii) are in my opinion only convenient analytical ways of expressing the general relation (ii). My sole object in referring to the matter is to meet Professor Kapteyn's charge, that I have largely profited by his paper and the suggestion that I had invented (iii) as a differential equation to frequency distributions after the appearance of that paper.

We now, having cleared off Professor Kapteyn's first two statements, come I think to the kernel of the matter. Neither (i) nor (iii) is more general than (ii), the whole problem turns on the proper and suitable choice of $F(x)$ in (i) or $f(x)$ in (iii) just as it turns on a proper choice of $\phi(x)$ in (ii). Up to this point neither party has made any real progress.

Kapteyn selects $F(x)=(x+\kappa)^q$, and I selected $f(x)=S(c_n x^n)$.

The test of the merits of the two selections must depend upon certain points which I will shortly consider. But first I would meet another remark of Kapteyn's. He says I stop at c_2, but he does not note why, although the reasons have been stated, i.e.

(i) I have given the expressions to deduce any c_n whatever, but the higher c's depend upon the high moments, which I have shown are subject to large percentage probable errors.

(ii) The c series converges in practice rapidly, the reducing factor being of the order of the skewness and the kurtosis, both of which are usually much smaller than unity. This is indicated by the general rough approach of most statistics as a first approximation to a Gaussian curve, and as a second approximation to a point binomial, and as a third approximation to the hypergeometrical series.

(iii) The sufficiency with which $f(x)=c_0+c_1x+c_2x^2$ gives actual frequency distributions.

These are the justifications for my own choice of $f(x)$.

To not one of my criticisms of Professor Kapteyn's choice of $F(x)$ does he make any reply *whatever*. I pointed out:

(i) That a good frequency-curve must be a graduation formula, and that Kapteyn by making his result depend on certain total areas had shown that he failed to realise this essential condition*.

(ii) That we ought in every frequency distribution to be able to realise the effect of the unit of grouping, but that Kapteyn's method wholly ignores this important point.

(iii) That the probable error of every constant involved ought to be ascertainable, and this is not the case with Kapteyn's constants; he finds for one case that his constant $q=0$ or $q=\infty$ give both a "pretty close" representation. As the whole range of q must lie between these arithmetical values, it is clear that it cannot be an important constant which will enable us to effectively discriminate between two allied distributions†.

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* Further: constants deduced from class frequencies are never as accurate as those deduced from moments. In fact they often are very bad indeed. Thus suppose it necessary to find the standard deviations (1) by moments, (2) by areas, say from the quartiles. Sheppard (*Phil. Trans.* Vol. 192 A, p. 134) has shown that if the total frequencies are n and n', the probable errors are $\cdot 74728\sigma\sqrt{n}$ and $\cdot 91908\sigma/\sqrt{n'}$ respectively. Or, if n were 1000, n' would have to be 1513 or 50 p.c. larger to obtain as good a result. The errors resulting from this source are as serious as the failure of 'class' fitting (when only the same number of classes are taken as constants to be determined) to graduate the observations.

† Professor Kapteyn's reply to this criticism is given above and it is, I venture to think, no reply at all. He says that it only shows "how widely different forms may be made to represent with tolerable precision the same frequency-curves." This gives the whole theory away. Any frequency distribution of n classes is absolutely determined by its moment-coefficients $\mu_2, \mu_3, \mu_4 \dots \mu_n$. The class frequencies can be expressed in terms of the μ's (Thiele) if enough are taken. Any constant therefore of the frequency distribution ought to be *uniquely* expressible in terms of these constants. After

(iv) That the fundamental physical constants are not ascertainable from Kapteyn's constants, and this alone seems to me sufficient to deprive his method of all practical significance.

(v) That his assumptions would involve the existence of a number of organic variables, the distribution of which followed a *truncated* normal curve; no such variables have been observed in the very wide biometrical experience we have had.

(vi) Further that if they did exist, we ought to discover a number of perfectly correlated organic characters. Hundreds of correlations between organic characters have now been investigated, but no case of perfect correlation has yet been discovered.

Professor Kapteyn instead of replying to my criticisms (i) to (vi) states that he has reached a result more general than Edgeworth's. This I fail entirely to agree with and I believe no mathematical logician would agree with it either. He next asserts that I have in some way purloined his result (i) under a form (iii). My reply is that (i) or (iii) are of no importance at all until we come to select forms for the arbitrary functions involved, and that if they were of importance, I am not indebted to Professor Kapteyn for form (iii), for I used it for years and published it some months before his paper appeared.

I am quite ready to leave the result even of testing the practical value of the two series of curves as *empirical* descriptions of frequency to the computator; and this for the simple reason that Kapteyn's curves have been tested by a trained computator and fail to fit at all in certain cases where mine do fit. The source of this failure is shown in my paper; Kapteyn has not got general skewness and general kurtosis with his formula. But of this more on another occasion. Kapteyn promises us a general method of determining the analytical form of his $F(x)$. I shall look forward to his paper with the greatest interest, for it involves indirectly no less than a revolution in physics. It amounts to the determination of the arbitrary analytical function which expresses the relation between two physical quantities, from a graph of their observed relationship. Clearly if we can find $F(x)$ in (i), it is identical with the discovery of $\phi(x)$, the functional form of the relation between two physical characters x and y. The solution will be of the greater value because every observed class $z=\int_{x_1}^{x_2} y\,dx$ is subject to the probable error $\cdot 67449\sqrt{z(1-z/N)}$ where N is the total frequency, so that the form of $F(x)$ has to be determined analytically, not from exact knowledge, but from a knowledge that y lies with a definite amount of probability within a certain belt of varying breadth. The gain in power to the poor physicist who is too apt to select $y=S(c_n x^n)$ to describe his observation curves will be enormous.

this is done the question to be answered is: What is its probable error? Every constant used in my frequency theory is uniquely and absolutely given as soon as the moment coefficients have been ascertained and its probable error can then be found. It is accordingly an absolutely significant constant for the frequency distribution quite apart from its relation to any special form of curve. And it may be compared from one distribution to a second, without any assumption as to the goodness of fit of curves. For example, just as we can test whether μ_2 differs significantly for two distributions, so we can also test whether any function,

$$f(\mu_2,\ \mu_3,\ \dots\ \mu_n),$$

differs significantly, and this will be one test of true differentiation in the distributions. Thus we may test if

$$\gamma=2\mu_2/\mu_3 \text{ and } p=4\mu_2^3/\mu_3^2-1$$

are significantly different for two distributions. This is perfectly legitimate whether we take γ and p constants of my curve (Type III) or not; they are unique functions of the μ's. But when Professor Kapteyn expresses his frequency in terms of a constant which may have values *in the same case* from 0 to ∞, it must be obvious that he has at once destroyed the fundamental purpose of frequency investigations, which lies in testing by the theory of probable errors the difference of random samples of two populations.

II. On the Curves which are most suitable for describing the frequency of Random Samples of a Population.

By KARL PEARSON, F.R.S.

(1) In determining the variability of random samples, or in other words in forming the probable error of a class frequency, an argument of the following kind is usually adopted: Let the chance of occurrence of an individual with a character of the given class be p, and $q=1-p$ be the chance of an individual not of this class occurring, then if a random sample of n individuals be taken the distribution of M such random samples will have frequencies given by the terms of the binomial $M(p+q)^n$.

The first four moment coefficients of this distribution about its mean[*] are:

$$\mu_2=c^2npq \qquad \text{(i)},$$

$$\mu_3=c^3npq\,(p-q) \qquad \text{(ii)},$$

$$\mu_4=c^4npq\,(3\,(n-2)\,pq+1) \qquad \text{(iii)}.$$

These lead to

$$\beta_1=\mu_3^2/\mu_2^3=\frac{1}{npq}-\frac{4}{n} \qquad \text{(iv)},$$

$$\beta_2=\mu_4/\mu_2^2=3+\frac{1}{npq}-\frac{6}{n} \qquad \text{(v)}.$$

Now if n be indefinitely large,—and neither p nor q be indefinitely small,—there results $\beta_1=0$ and $\beta_3=3$, i.e. no skewness and mesokurtosis[†]. Accordingly, as is well known, the binomial passes over into the symmetrical (or Gaussian) normal curve of errors, with a standard deviation $c\sqrt{npq}$. The great bulk of investigators,—at least of the wiser class who know the importance of basing inferences on probable errors—are thus accustomed to content themselves with calculating the probable error of a class frequency from the formula

$$\text{P.E.}=\cdot 67449\sqrt{npq} \qquad \text{(vi)},$$

c, the group base, being taken as unity. The odds against the correspondence between an observed class frequency and its theoretical value are then calculated from tables of the probability integral. In other words the distribution of random samples of a class frequency is assumed to follow the normal curve

$$y=y_0e^{-\frac{1}{2}x^2/\sigma^2} \qquad \text{(vii)},$$

where

$$\sigma=\sqrt{npq}.$$

The validity of this process for practical statistics remains unquestioned, provided n is fairly large and neither p nor q approximate to zero[‡]. Historically this is the very problem, for the solution of which the probability integral and the normal curve were introduced.

But if any frequency distribution be examined, we find class frequencies, which are themselves small, for example often small classes towards the extreme values of the character, and it is not legitimate to put $\beta_1=0$ and $\beta_2-3=0$ and adopt the normal curve in considering the probable error of such class frequencies; for, although n be fairly large p will be very small and np, the frequency of the class in the sample, be possibly only a few units. Thus the value of $1/(npq)$ may easily range from unity downwards. For example, if $n=1000$ and $np=2$ or 3 we cannot possibly consider the skewness represented by $\beta_1=\cdot 3$ to $\cdot 5$ or the kurtosis $\beta_2-3=\cdot 3$ to $\cdot 5$ as passably corresponding to a symmetrical, mesokurtic Gaussian curve of errors.

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[*] Pearson: *Phil. Trans.* Vol. 186 A, p. 347.

[†] *Biometrika*, Vol. IV. p. 173.

[‡] Thus Mendelian halves and quarters with 100 to several hundred individuals in the series may be quite effectively tested in this manner.

A similar difficulty arises whatever values we take for p and q (between 0 and 1) if n itself be small, i.e. if we are dealing with random samples of small size.

To surmount this difficulty we are compelled to return to the original binomial $M(p+q)^n$.

Now the calculation of any number of the terms of this binomial is very troublesome, especially when n is large, but np small. Accordingly we need an integral which will stand as closely to the sum of the first s terms of this binomial for *any* values of n and p, as the normal probability integral does to the same sum when n is large and p moderate. This expression is directly and effectively provided by the curve*

$$y=y_0 e^{-\gamma x}\left(1+\frac{\gamma x}{m}\right)^m \quad \text{......(viii)},$$

where

$$m=4\left(\frac{1}{npq}-\frac{4}{n}\right)-1 \quad \text{......(ix)},$$

$$\gamma=\frac{2}{c}\,\frac{1}{p-q} \quad \text{......(x)},$$

and

$$y_0=M/a\,.\,m^{m+1}e^{-m}/\Gamma(m+1) \quad \text{......(xi)}.$$

c of course will usually be taken unity and the origin is the mode or maximum frequency. The areas of this curve give as completely as the probability integral does the odds against any observed deviation from the modal value.

It will be obvious that to find the odds against any given deviation we require the ratio of an incomplete to a complete Γ-function. Numerical tables to assist the calculation of incomplete Γ- and incomplete β-functions are nearly finished and will be shortly published.

Thus within these limits a solution is reached for the problem of the probable error of random sampling when n, p, q are anything whatever.

(2) The whole of the preceding investigation is, however, subject to a limitation which often escapes notice. We have supposed the chance of any individual arising with the character of a given class to be p, and that this chance remains constant throughout the collection of the sample. This statement of the problem is however incorrect, when the size of the sample is in any manner commensurable with the total population from which it is drawn. Such cases are by no means uncommon in the treatment of vital statistics for the case of man. Further in the consideration of determinant theories of inheritance, when the character of the individual depends on the random sampling of a finite number of determinants, the size of the sample not being small as compared with the number of selectable determinants, we are again excluded from using either the probability integral or the incomplete Γ-function for the determination of the distribution.

For example, if a cell-division leads to the exclusion of n' determinants out of $N=n+n'$ available determinants, where n and n' are commensurable, it is not possible to approach the matter as we have done above; for in the cases treated n' is supposed large as compared with n. We accordingly reach the following more general problem:

A population consists of N individuals, Np of which possess a given character and Nq do not, what will be the distribution of frequency in this character for M random samples of magnitude n which is commensurable with N?

The solution is of course the hypergeometrical series

$$M\,.\,\frac{pN(pN-1)\dots(pN-n+1)}{N(N-1)\dots(N-n+1)}\left\{1+n\,\frac{qN}{pN-n+1}+\frac{n(n-1)}{1\,.\,2}\,\frac{qN(qN-1)}{(pN-n+1)(pN-n+2)}\right.$$
$$\left.+\frac{n(n-1)(n-2)}{1\,.\,2\,.\,3}\,\frac{qN(qN-1)(qN-2)}{(pN-n+1)(pN-n+2)(pN-n+3)}+\dots\right\} \quad \text{...(xii)}.$$

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* Skew-Curve of Type III: see *Phil. Trans.* Vol. 186 A, p. 373.

Thus the hypergeometrical series, and not the point binomials (or their limits either the normal curve or Type III skew curve), form the general solution to the problem of random sampling.

If we wish to consider the odds against any observed deviation from the most probable result for a class frequency, we must accordingly endeavour to determine the value of the first s terms of the above hypergeometrical series. But the labour of such an investigation is great and we are naturally thrown back, as Laplace was, on the discovery of an integral which will replace the finite difference series.

I have shown* in an earlier paper what are the values of the moments of the hypergeometrical series. In the notation of the present memoir, we have

$$\mu_2 = c^2 npq\left(1-\frac{n-1}{N-1}\right) \quad\text{......(xiii)},$$

$$\mu_3 = c^3 npq\,(p-q)\left(1-\frac{n-1}{N-1}\right)\left(1-\frac{2\,(n-1)}{N-2}\right) \quad\text{......(xiv)},$$

$$\mu_4 = c^4 npq\left(1-\frac{n-1}{N-1}\right)\left\{1-\frac{6\,(n-1)}{N-2}\left(1-\frac{n-2}{N-3}\right) + 3pq\,(n-2)\left(1-\frac{n-1}{N-2}\left[\frac{n-10}{n-2}+\frac{9}{N-3}\right]\right)\right\} \quad\text{......(xv)}.$$

The mean value is at a distance $c(1+nq)$ from the left-hand zero start of the series, i.e. cnq from the value when the sample consists wholly of individuals with the character, and this is identical with the mean value calculated on the basis of the binomial $(p+q)^n$.

If n and N are both large, but still commensurable, the above results reduce to the simpler forms:

$$\mu_2 = c^2 npq\left(1-\frac{n}{N}\right) \quad\text{......(xvi)},$$

$$\mu_3 = c^3 npq\,(p-q)\left(1-\frac{n}{N}\right)\left(1-\frac{2n}{N}\right) \quad\text{......(xvii)},$$

$$\mu_4 = c^4 npq\left(1-\frac{n}{N}\right)\left\{1+3npq\left(1-\frac{n}{N}\right)-6\frac{n}{N}\left(1-\frac{n}{N}\right)\right\} \quad\text{......(xviii)}.$$

It will thus be clear that when the sample is commensurable with the population from which it is drawn, the standard deviation of the class frequency must no longer be taken $\sqrt{npq}$, but $\sqrt{npq\,(N-n)/(N-1)}$, a result which even if we now use tables of the probability integral will give us a very different value for the probable error in the class frequency. But it is clear that we ought not to use such probability integral tables, we ought to replace the sum of the first s terms of the hypergeometrical by an integral which gives the value of this sum with a degree of accuracy similar to that with which the probability integral in like case gives the symmetrical binomial. But such integrals representing the areas of certain curves fitting closely to the hypergeometrical series were provided by my memoir of 1895†.

It is there shown that if

$$p \text{ lie between } \tfrac{1}{2} \pm \sqrt{\frac{1}{N}\left(1+\frac{1}{N}\right)},$$

the sums of the series are closely given by the areas of the curve

$$y = \frac{y_0}{\left(1+\dfrac{x^2}{a^2}\right)^m} e^{-\nu \tan^{-1} x/a} \quad\text{......(xix)},$$

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* *Phil. Mag.* Feb. 1899, p. 239.

† *Phil. Trans. loc. cit.* p. 361 and seq.

where

$$\left.\begin{aligned} a&=\tfrac{1}{4}c\sqrt{4(1+pN)(1+qN)-(N-2n)^2}\\ \nu&=\frac{N(N-2n)(p-q)}{\sqrt{4(1+pN)(1+qN)-(N-2n)^2}}\\ m&=\tfrac{1}{2}(N+2)\end{aligned}\right\}\text{..........................(xx).}$$

If on the other hand p lies outside the above limits, then the sum of the series is given by the areas of the curve

$$y=y_0\left(1-\frac{x}{a_1}\right)^{-\nu a_1}\left(1-\frac{x}{a_2}\right)^{\nu a_2}\quad\text{..............................(xxi),}$$

where a_1 and a_2 are the roots of the quadratic equation

$$\left.\begin{aligned} &\frac{c^2(n+1)(N-n+1)(1+qN)(1+pN)}{(N+2)^2}+\frac{cN(N-2n)(p-q)}{2(N+2)}x+x^2=0\\ \text{and}\qquad &\nu=(N+2)/(a_1-a_2)\end{aligned}\right\}\text{......(xxii).}$$

Thus, (xix) which falls under my skew curve Type IV, and (xxii) which is included in my skew curves of Type I, complete the full solution of the problem of the random sample.

The partial integrals of (xix) and (xxi), which can be fairly easily found graphically, fall under the incomplete G-function*, and the incomplete β-function.

The incomplete Γ- and β-functions can be determined by aid of tables which have just been calculated and will shortly be published.

Thus we see that the skew curves (vi), (xix) and (xxii) directly arise in the course of our investigations when we come to deal in full generality with the problem of random sampling. But what we know so far of cell-division and determinantal theories of inheritance suggests forcibly that the character of any sub-class of a population is fixed by a random sample of a number of determinants, the size of the sample being commensurable with the number of determinants. In all such cases the distribution of frequency will approximate to the curves we have here discussed. They thus cease to be approximations in any other sense than the Gaussian or normal curve is an approximation when the probability integral is used to determine the probable error of a random sample.

It is true, indeed, that they contain a good deal more than the general theory of random samples. Thus the general frequency curve must be of the form

$$\frac{1}{y}\frac{dy}{dx}=\frac{x+a}{f(x)}.$$

If we take

$$f(x)=c_0+c_1\frac{x}{\sigma}+c_2\left(\frac{x}{\sigma}\right)^2+\dots+c_s\left(\frac{x}{\sigma}\right)^s+\dots,$$

then I have given the finite difference equation which determines the successive c's in terms of the moments and shown that the convergency ratio of the successive constants is a factor (less than unity like in general the skewness and kurtosis) which vanishes for the normal curve. It will, I think, be obvious that to give the general rule for finding as many terms as we please, give their degree of convergency, and then retain three because they are found to fulfil all practical requirements is a process more legitimate than to assume every function must be of the form

$$F(x)=(x+\kappa)^q,$$

and give no measure at all of the deviation from this form, and no statistical illustration (such as that of random sampling) in which such a function habitually and necessarily arises. Yet such is the course recently adopted by Professor Kapteyn and considered by him "rational" as compared with mine.

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* I term the complete G-function, $G(r,\nu)=\int_0^\pi \sin^r\theta e^{+\nu\theta}\,d\theta$. This has been tabled by Dr A. Lee, *B. A. Report*, Dover, 1899. The incomplete G-function is $G(r,\nu,\theta)=\int_0^\theta \sin^r\theta e^{\nu\theta}\,d\theta$, and has not yet been dealt with.

III. On certain Points connected with scale Order in the Case of the Correlation of two characters which for some arrangement give a Linear Regression Line.

By KARL PEARSON, F.R.S.

In a recent memoir on contingency*, I have considered the problem of what alterations can be made in scale order without sensibly modifying the value of the correlation. The problem as I there state it is as follows: *To find under what other condition than normal correlation small changes in the order of grouping will not affect the value of the correlation* (p. 19). The wording requires some explanation. If for any arrangement of the scales of the two variables there be normal correlation, then my memoir shows that the method of contingency gives the value of the correlation, even if the order of the scales be any whatever, in fact if the normal correlation order be absolutely unknown. Of course, if we proceed in any such case by the usual product method of determining the correlation we shall reach absolutely different results when the scale order of grouping is largely changed. My object in stating the above problem was to determine, if possible, whether any and if so what changes in the scale orders would not sensibly modify the correlation, when we still endeavoured to determine it, not by contingency, but by the method of products. The conclusion I came to was as follows—that with any distribution *with linear regression* "small changes (i.e. such that the sum of their squares may be neglected as compared with the square of mean or standard deviation) may be made in the order of grouping without affecting the correlation coefficient" (p. 35). I think this conclusion is quite sound, and deserves further consideration. Although in the statement of the proposition I have used the word "small changes" in scale order (p. 19) and in the summary of my memoir (p. 35) stated what is to be understood by small, in this case, I think, as Mr G. U. Yule points out to me, that the wording on p. 20 is too unguarded, if the reader has not been sufficiently impressed with the wording on p. 19, or reached the summary on p. 35. It will not be without value possibly to give the actual algebraical result on which the statement on p. 35 is based, for it has some importance for the general philosophical idea of correlation.

Let x and y represent the two variable characters and let $u\delta x$ be the frequency of the character between x and $x+\delta x$; $v\delta y$ that of the character between y and $y+\delta y$; u and v being functions of x and y respectively and the distribution of the frequencies being of any nature. Now suppose the array $v_s\delta y_s$ of frequency between y_s and $y_s+\delta y_s$ to be bodily interchanged in position with the array $v_{s'}\delta y_{s'}$ between $y_{s'}$ and $y_{s'}+\delta y_{s'}$. Let N be the total frequency, and suppose the mean $\bar{y}$ to become $\bar{y}+\delta\bar{y}$, the standard deviation σ_y of the y character to become $\sigma_y+\delta\sigma_y$. Then we have:

$$N(\bar{y}+\delta\bar{y})=S(yv\delta y)-v_{s'}\delta y_{s'}(y_{s'}-y_s)-v_s\delta y_s(y_s-y_{s'})$$

or

$$\delta\bar{y}=(y_s-y_{s'})\frac{(v_{s'}\delta y_{s'}-v_s\delta y_s)}{N} \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{(i)},$$

$$\begin{aligned}N(\sigma_y+\delta\sigma_y)^2&=S(y^2v\delta y)-v_{s'}\delta y_{s'}(y_{s'}^2-y_s^2)-v_s\delta y_s(y_s^2-y_{s'}^2)-N(\bar{y}+\delta\bar{y})^2\\&=N\sigma_y^2+(v_{s'}\delta y_{s'}-v_s\delta y_s)(y_s^2-y_{s'}^2)-2\bar{y}(y_s-y_{s'})(v_{s'}\delta y_{s'}-v_s\delta y_s),\end{aligned}$$

$$N(\delta\sigma_y)^2+2N\sigma_y\delta\sigma_y=(v_{s'}\delta y_{s'}-v_s\delta y_s)(y_s-y_{s'})(y_s-\bar{y}+y_{s'}-\bar{y}).$$

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* "Mathematical Contributions to the Theory of Evolution, III. On the Theory of Contingency and its Relation to Association and Normal Correlation." *Drapers' Research Memoirs* (Dulau and Co. London).

Hence we see that $\delta\sigma_y$ is small, if the frequencies of interchanged subgroups are small as compared with N and accordingly:

$$\delta\sigma_y/\sigma_y = \frac{v_{s'}\delta y_{s'} - v_s\delta y_s}{N}\,\frac{(y_s - y_{s'})}{\sigma_y}\,\frac{y_s - \bar{y} + y_{s'} - \bar{y}}{2\sigma_y} \quad \text{.......................(ii).}$$

We now turn to the change in the product-moment.

$$P + \delta P = S(wxy\delta x\delta y) - v_{s'}\delta y_{s'}\bar{x}_{s'}(y_{s'} - y_s) - v_s\delta y_s\bar{x}_s(y_s - y_{s'}) - N\bar{x}(\bar{y} + \delta\bar{y}),$$

where $w\delta x\delta y$ is the total frequency of individuals, with characters between x and $x + \delta x$ and y and $y + \delta y$ and $\bar{x}_s$ and $\bar{x}_{s'}$ are the means of the arrays corresponding to y_s and $y_{s'}$. But $P = S(wxy\,\delta x\delta y) - N\bar{x}\bar{y}$, hence:

$$\delta P = (y_s - y_{s'})\left((\bar{x}_{s'} - \bar{x})\,v_{s'}\delta y_{s'} - (\bar{x}_s - \bar{x})\,v_s\delta y_s\right).$$

Thus
$$\delta P/P = \frac{y_s - y_{s'}}{\sigma_y}\left(\frac{\bar{x}_{s'} - \bar{x}}{r\sigma_x}\,\frac{v_{s'}\delta y_{s'}}{N} - \frac{(\bar{x}_s - \bar{x})}{r\sigma_x}\,\frac{v_s\delta y_s}{N}\right) \quad \text{.......................(iii).}$$

Now if r be the correlation before and $r + \delta r$ after a change is made, we have, since $r = P/(N\sigma_x\sigma_y)$,

$$\frac{\delta r}{r} = \frac{\delta P}{P} - \frac{\delta\sigma_x}{\sigma_x} - \frac{\delta\sigma_y}{\sigma_y} \quad \text{.....................................(iv).}$$

Now we have supposed at present no change to be made in the x's; thus we may treat $\delta\sigma_x$ as zero, and using (ii) and (iii) we have, rearranging:

$$\frac{\delta r}{r} = \frac{y_s - y_{s'}}{r\sigma_y\sigma_x}\left[\frac{v_{s'}\delta y_{s'}}{N}\left\{\bar{x}_{s'} - \bar{x} - \frac{r\sigma_x}{\sigma_y}(y_{s'} - \bar{y})\right\} - \frac{v_s\delta y_s}{N}\left\{\bar{x}_s - \bar{x} - \frac{r\sigma_x}{\sigma_y}(y_s - \bar{y})\right\}\right]$$
$$- \frac{(y_s - y_{s'})^2}{2\sigma_y^2}\,\frac{v_{s'}\delta y_{s'} + v_s\delta y_s}{N} \quad \text{......(v).}$$

Now suppose the regression to be originally linear, then we have $\bar{x}_s - \bar{x} = \frac{r\sigma_x}{\sigma_y}(y_s - \bar{y})$ not only for s and s' but for all values of s whatever. In other words the whole series of terms in square brackets vanishes and summing for all pairs of interchanges:

$$\frac{\delta r}{r} = -\frac{S(y_s - y_{s'})^2(v_{s'}\delta y_{s'} + v_s\delta y_s)}{2N\sigma_y^2} \quad \text{.............................(vi).}$$

If we make similar interchanges of x_p and $x_{p'}$ we can show that*:

$$\frac{\delta r}{r} = -\frac{S(y_s - y_{s'})^2(v_{s'}\delta y_{s'} + v_s\delta y_s)}{2N\sigma_y^2} - \frac{S'(x_p - x_{p'})^2(u_{p'}\delta x_{p'} + u_p\delta x_p)}{2N\sigma_x^2}$$
$$+ \frac{S'''(y_s - y_{s'})(x_p - x_{p'})(w_1\delta x_p\delta y_s - w_2\delta x_{p'}\delta y_s - w_3\delta x_p\delta y_{s'} + w_4\delta x_{p'}\delta y_{s'})}{Nr\sigma_x\sigma_y} \quad \text{...(vi) bis.}$$

Here S denotes a summation or integration for all possible interchanges of the y arrays, i.e. say, columns of the correlation table; and S' denotes a like summation for all possible interchanges of the x-arrays, say the rows of the table. S''' is a summation involving the frequency at all points where interchanged rows and columns cross. Of course this result assumes that the units of grouping of both characters are so "fine" that the squares of the ratios of the array frequencies to the total frequency are negligible.

We may now draw some interesting conclusions from (vi). Suppose the material to be such that the correlation is linear under some arrangement. Then for slight interchanges the squares and products of the interchanges are negligible and δr will be zero. Thus, r being positive, we see from (vi) that r is an absolute maximum. Clearly $\delta r/r$ is always negative even for interchanges between arrays at considerable distances. Or, we conclude that if there be one arrangement of the material for which the regression line is linear, then any interchanges, however extensive, will reduce the value of the correlation as calculated by the product moment method. This conception of the linear regression line as giving the arrangement with the maximum degree of correlation appears of considerable philosophical interest. It amounts practically to much the same thing as saying that if we have a fine classification, we shall get the maximum of correlation by arranging the arrays so that the means of the arrays fall as closely as possible on a line.

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* The reader will find a verification of this formula arising from writing (i) the correlation table with its columns inverted, then $\delta r/r = -2$, and (ii) again in addition with its rows written backwards, in this case $\delta r/r = 0$. In (i) the first term only remains and its numerator $= 4N\sigma_y^2$. In the second case the numerators of the three terms are respectively $4N\sigma_y^2$, $4N\sigma_x^2$ and $4Nr\sigma_x\sigma_y$.

Further, if the mean square of the interchanges, i.e. the expression

$$\frac{S(y_s - y_{s'})^2 (v_{s'}\delta y_{s'} + v_s \delta y_s)}{2N},$$

be small as compared with the standard deviation squared, i.e. $\sigma_y{}^2$, then the change δr will not be sensible. In other words *small* changes in the scale ordering, not confined to adjacent or even to two arrays, will not sensibly modify the correlation as found by the product moment method.

Lastly, considering the proof of (vi) we see that no portion of the investigation is dependent on the whole of the one y-array being interchanged with the whole of another. We may consider $v_s\delta y_s$ and $v_{s'}\delta y_{s'}$ as only portions of the total array—to be taken, however, proportionately from all its constituents. Now let $V_s\delta y_s$ and $V_{s'}\delta y_{s'}$ denote the whole of the frequency of the two arrays, and write the first array $V_s\delta y_s + \frac{1}{2}m - \frac{1}{2}m$ and the second array $V_{s'}\delta y_{s'} - \frac{1}{2}m + \frac{1}{2}m$. Now transfer the $-\frac{1}{2}m$ of the first array to the position of the second and the $+\frac{1}{2}m$ of the second to the position of the first, i.e. take $v_s\delta y_s = -\frac{1}{2}m$ and $v_{s'}\delta y_{s'} = +\frac{1}{2}m$; it follows that $v_s\delta y_s + v_{s'}\delta y_{s'} = 0$ and the two arrays are

$$V_s\delta y_s + m \text{ and } V_{s'}\delta y_{s'} - m,$$

i.e. exactly the values they would have had if a portion of the second array drawn at random from all its sub-groups had been inscribed in the same sub-groups of the first array. But in this case we see since $v_s\delta y_s + v_{s'}\delta y_{s'} = 0$, that (vi) will give us absolutely $\delta r = 0$, or there will be no change in the correlation. This result seems of considerable value. Suppose the regression linear, and one character, x say, easily measured or known; then if a number m of individuals which ought to fall into a given class of y, be shifted by oversight or error of judgment into a second erroneous class of y, this will not sensibly affect the correlation, if N being the total frequency, the square of the ratio m/N is negligible, as compared with its first power. Thus suppose in correlating age with hair tint, the first character being accurately known, an observer were to place his series of contributory observations of hair tint in the wrong group, say in one of the brown reds instead of pure browns, this would not sensibly modify the resulting correlation. The fact that the error would not produce a modification is not in the first place due to the possible smallness of the misplaced group. The product moment is changed and the standard deviation is also modified, but the modification of the correlation depends on such manner on the changes of these two, that they act in opposite senses and cancel the modification, provided the original regression was strictly linear.

While not desiring to encourage carelessness in observing or tabling or in the formation of scale orders without due consideration, still the results of this note seem to indicate that in many cases absolute unanimity of judgment in classifying or great stress on small details of scale grouping are not needful in order to reach sensibly identical values of the correlation. This view coincides with my actual and not unique experience, when having been in grave doubt as to where 30 or 40 individuals were to be placed, I put them first in one category and then in a second, only to find out that the correlation worked out with the group first in one and then in the other category was sensibly identical. The theorems developed in this note seem to explain this stability—when we use not contingency but product moment methods, and suppose the regression ultimately linear.

IV. On the Classification of Frequency-ratios†.

BY D. M. Y. SOMMERVILLE, D.Sc.

In statistical work which deals with integral variates, the data frequently appear in the form of ratios, or unreduced proper fractions; and to facilitate comparison these are arranged in classes according to magnitude, all the ratios falling within the same class being considered as equivalent. The problem then arises to find the best distribution of the fractions so that there may be approximately the same number in each class; or, if the fractions with various denominators do not all occur with the same frequency so that it is necessary to assign to them certain weights, to find the distribution which will make the total weight of each class approximately the same.

I. Let $*/\overline{p}$ denote any proper fraction with the denominator p, and $*/\overline{\ngtr n}$ the assemblage of all the proper fractions whose denominators do not exceed n. The following theorem is then established:

If the fractions $*/\overline{\ngtr n}$ are distributed into n classes, $\frac{0}{n}$ to $\frac{1}{n}$, $\frac{1}{n}$ to $\frac{2}{n}$, ..., $\frac{n-1}{n}$ to $\frac{n}{n}$, and any fraction which falls between two classes is counted $\frac{1}{2}$ in each of these two classes, each of the others being counted 1 in the class in which it occurs, then in each class there will fall $\frac{1}{2}(n+1)$ fractions, except in the extremes which contain $n+\frac{1}{2}$.

[If the fractions at the extremes, $\frac{0}{1}, \frac{0}{2}, \ldots, \frac{0}{n}; \frac{1}{1}, \frac{2}{2}, \ldots, \frac{n}{n}$, are also counted $\frac{1}{2}$ there will be $\frac{1}{2}(n+1)$ fractions in the extreme classes also.]

This is the *normal distribution* (N.D.).

There are three other "even" distributions:

(1) $n-1$ classes, $\frac{1}{2}(n+2)$ in each, extremes $n+\frac{3}{2}$.

(2) $n+1$ classes, $\frac{1}{2}n$ in each, extremes n.

(3) $n+2$ classes, $\frac{1}{2}(n-1)$ in each, extremes n.

These are obtained from the N.D. for $n-1$, $n+1$, $n+2$ respectively.

Then by making pairs of classes coalesce, from the second onwards, we get the following evenest distributions:

(1) n even: $\frac{1}{2}n+1$ classes, 0 to $\frac{1}{n}$, $\frac{1}{n}$ to $\frac{3}{n}$, ..., $n+1$ in each, extremes $n+\frac{1}{2}$.

(2) n odd: $\frac{1}{2}(n+3)$ classes, 0 to $\frac{1}{n+1}$, $\frac{1}{n+1}$ to $\frac{3}{n+1}$, ..., n in each.

The N.D. can be easily written down. To find the classes in which $*/\overline{p}$ occurs, divide $n, 2n, 3n, \ldots$ by p; let $q_1, q_2, q_3, \ldots$ be the quotients and $f_1, f_2, f_3, \ldots$ the remainders. Then if $f_s \neq 0$, $\frac{s}{p}$ lies in the (q_s+1)th class, but if $f_s=0$, $\frac{s}{p}=\frac{q_s}{n}$ and $\frac{s}{p}$ lies $\frac{1}{2}$ in the q_sth and $\frac{1}{2}$ in the (q_s+1)th class. Each class must contain either $*/\overline{p}$ or $*/\overline{n-p}$, and if any class contains both, each of them is counted ½. Writing the classes horizontally with the fractions $*/\overline{p}$ in columns under their respective denominators, the N.D. for $n=12$ is represented as follows:

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† Abstract by the Author of a paper "On the Distribution of the Proper Fractions," by D. M. Y. Sommerville, D.Sc., *Proc. Roy. Soc. Edin.* Vol. XXXVI. (1906), pp. 116—129.

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
0	0	0	0	0	0	0	0	0	0	0	${}^{0}{}_{\overline{1}}$
					$\overline{1}$	1	1	1	1	1	${}^{\overline{1}}{}_{\overline{2}}$
			$\overline{1}$	1	$\overline{1}$		$\overline{2}$	2	2	2	${}^{\overline{2}}{}_{\overline{3}}$
		$\overline{1}$	$\overline{1}$		$\overline{2}$	2	$\overline{2}$	$\overline{3}$	3	3	${}^{\overline{3}}{}_{\overline{4}}$
		$\overline{1}$		2	$\overline{2}$		3	$\overline{3}$	4	4	${}^{\overline{4}}{}_{\overline{5}}$
	$\overline{1}$		$\overline{2}$		$\overline{3}$	3	$\overline{4}$	4	$\overline{5}$	5	${}^{\overline{5}}{}_{\overline{6}}$
	$\overline{1}$		$\overline{2}$		$\overline{3}$	4	$\overline{4}$	5	$\overline{5}$	6	${}^{\overline{6}}{}_{\overline{7}}$
		$\overline{2}$		3	$\overline{4}$		5	$\overline{6}$	6	7	${}^{7}{}_{\overline{8}}$
		$\overline{2}$	$\overline{3}$		$\overline{4}$	5	$\overline{6}$	$\overline{6}$	7	8	${}^{\overline{8}}{}_{\overline{9}}$
			$\overline{3}$	4	$\overline{5}$		$\overline{6}$	7	8	9	${}^{\overline{9}}{}_{\overline{10}}$
					$\overline{5}$	6	7	8	9	10	${}^{\overline{10}}{}_{\overline{11}}$
1	2	3	4	5	6	7	8	9	10	11	${}^{\overline{11}}{}_{12}$

A bar denotes that the fraction is counted ½.

II. Giving weights μ_p to the various denominators and expressing that the normal distribution is even, we get a series of equations,

$$\mu_p = \mu_{n-p},$$

i.e. the frequency-curve for the denominators must be symmetrical.

If we divide the fractions $*/\overline{\not> n}$ into $n+m$ classes, then we have to divide the fractions $*/\overline{\not> (n+m)}$ normally and consider $\mu_p = 0$ if $p > n$ and therefore also if $p < m$. Also if $p \gtreqless m$, $\mu_p = \mu_{n+m-p}$. Hence if the frequency-curve is symmetrical from m to n ($n+m$ being even), and if the denominators $< m$ may be neglected, we may divide the fractions $*/\overline{\not> n}$ into $n+m$ classes, and then make pairs of classes from the second onwards coalesce. We have then the distribution into $\frac{1}{2}(n+m+2)$ classes, 0 to $\frac{1}{n+m}$, $\frac{1}{n+m}$ to $\frac{3}{n+m}$, ..., each of weight $\sum\limits_{p=m}^{p=n} \mu_p$.

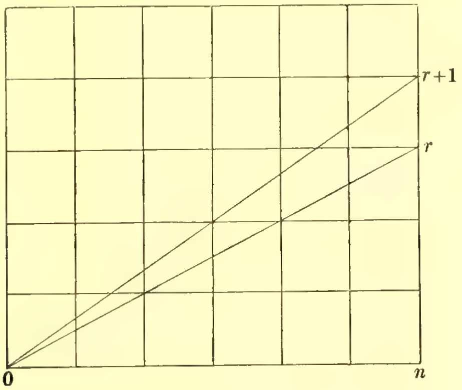
The general case where the frequency-curve is skew is not solved, but by considering it as symmetrical about the mode, e.g., and neglecting the lower denominators, as above, it may be possible to obtain an approximate solution, provided the mode lies among the higher denominators.

For other results which are only true when the extreme fractions are counted ½ we may refer to the complete paper.

The following graphical method of obtaining the first theorem was communicated to me by Professor Steggall.

Any positive fraction can be represented uniquely in the positive region of the plane by a point whose coordinates x, y are respectively the numerator and denominator. The lines $y=0$, $x=y$, $x=n$ will then confine all the proper fractions $*/\overline{\not> n}$. These are divided into the classes described above by the lines $rx = ny$ ($r = 0, 1, \ldots, n$). The number of fractions in the class

r/n to $(r+1)/n$ is then the number of representative points confined between the lines $rx=ny$, $(r+1)x=ny$, i.e. $\frac{1}{2}(r+2)(n+1)-\frac{1}{2}(r+1)(n+1)=\frac{1}{2}(n+1)$, counting $0/0$ as $\frac{1}{2}$. This fraction, which occurs in each class, disappears when we make the subtraction, and we have the result stated above.



V. Note on the Significant or Non-significant character of a Sub-sample drawn from a Sample.

By KARL PEARSON, F.R.S.

If two independent samples be drawn from an indefinitely large group or population, and their means be m and M' and their sizes n and N', and their standard deviations σ and Σ', then the usual test of significant and non-significant difference in type is made by comparing the difference of mean $m-M'$ with the probable error of this difference $\cdot 67449\sqrt{\sigma^2/n+\Sigma'^2/N'}$. This process may be considered as legitimate, if the samples are absolutely independent and drawn from an indefinitely large population.

It has become not unusual to apply this test to cases of the following kind, where its application has yet to be justified: a population is described by a sample, say N in size, M in type and Σ in variability. This sample is obtained from p localities, or if in one locality by p methods or instances, or generally there is a p-fold heterogeneity in its collection. One of the p sub-groups of the sample is defined by n, m and σ. It is frequently assumed that the proper test for significant or non-significant difference between the sub-sample and the general sample is the relative magnitude of $m-M$ and $\cdot 67449\sqrt{\frac{\sigma^2}{n}+\frac{\Sigma^2}{N}}$. This treatment is, I think, erroneous. To begin with it must be observed that as the sub-sample is made larger and larger, the value of its mean must approach closer and closer to that of the general sample, and thus the probable error of the difference ought to be less and less and ultimately vanish. Instead of this it approaches the finite value $\cdot 67449\sqrt{2\Sigma^2/N}$. Clearly the above expression for the probable error of the difference of types in sub-sample and sample is not correct. We have yet to ascertain how far it is approximate, when N is large as compared with n.

The sort of problem to which the above doubtful process is applied is of the following kind, for example: a general sample of the population is found to have q per cent. of its members affected by a certain disease or associated with a certain characteristic. A sub-sample marking a class or locality is found to have q' of its members thus differentiated. Does the group marked by the sub-sample differ significantly from the general sample out of which it is drawn? Or, again, do children of a particular parentage differ in physique from those of the general population, the test being made on a sample and a sub-sample of the school population?

I would suggest the following method of approaching the problem. Consider the general sample (N, M, Σ) to consist of two component samples, the sub-sample (n, m, σ) and all the remainder (N', M', Σ'). Then if the whole sample be homogeneous and random, and the two components also homogeneous and random, their difference of types $m-M'$ will have for its probable error:

$$E_{(m-M')} = \cdot 67449 \sqrt{\frac{\sigma^2}{n}+\frac{\Sigma'^2}{N'}}.$$

The test therefore of the difference being due to random sampling is the relative magnitude of

$$m-M' \quad \text{and} \quad E_{(m-M')}.$$

But if we consider the general sample we have at once:

$$N = N'+n, \qquad \text{or}: \quad N' = N-n,$$

$$M = (N'M'+nm)/N, \quad \text{or}: \quad M' = M+\frac{n}{N-n}(M-m),$$

$$N\Sigma^2 = n\{\sigma^2+(m-M)^2\}+N'\{\Sigma'^2+(M-M')^2\},$$

or:

$$\Sigma'^2 = \frac{N\Sigma^2-n\sigma^2}{N-n} - \frac{nN}{(N-n)^2}(M-m)^2.$$

Accordingly:

$$m-M' = \frac{N}{N-n}(m-M),$$

$$\frac{\Sigma'^2}{N'}+\frac{\sigma^2}{n} = \left(\frac{N}{N-n}\right)^2\left(\frac{\Sigma^2}{N}+\frac{\sigma^2}{n}\left(1-\frac{2n}{N}\right)-\frac{n(M-m)^2}{N(N-n)}\right).$$

Or we must compare the relative magnitude of:

$$\frac{N}{N-n}(m-M) \quad \text{and} \quad \cdot 67449\frac{N}{N-n}\sqrt{\frac{\Sigma^2}{N}+\frac{\sigma^2}{n}\left(1-\frac{2n}{N}\right)-\frac{n(M-m)^2}{N(N-n)}}.$$

In other words, the probable error of the difference in type of the general sample and the sub-sample, or of $m-M$, is:

$$\cdot 67449\sqrt{\frac{\Sigma^2}{N}+\frac{\sigma^2}{n}\left(1-\frac{2n}{N}\right)-\frac{n(M-m)^2}{N(N-n)}}.$$

This expression satisfies the requisite condition of becoming zero as the sub-sample increases in magnitude up to the value of the general sample.

Now if N be large as compared with n, clearly the important term in this expression is σ^2/n and $M-m$ will be of the order $v\sqrt{\sigma^2/n}$, where v is a small integer, 1, 2 or 3, say. Hence the order of the last term in the root is:

$$v^2\sigma^2/N^2,$$

or, since σ will not differ very widely from Σ, we may say $v^2\Sigma^2/N^2$. Now the probable error of Σ is $\cdot 67449\frac{\Sigma}{\sqrt{2N}}$ and accordingly if we put $\Sigma\left(1\pm\frac{\cdot 67449}{\sqrt{2N}}\right)$ for Σ we should not alter significantly the first term under the radical; thus Σ^2/N may be read:

$$\frac{\Sigma^2}{N}\left(1\pm\frac{\cdot 67449}{\sqrt{2N}}\right)^2 \quad \text{or} \quad \frac{\Sigma^2}{N}\left\{1\pm\frac{w}{\sqrt{N}}\right\},$$

where w is a small number. But n being small the first and last terms give:

$$\frac{\Sigma^2}{N}\left(1-\frac{v^2}{N}\right)=\frac{\Sigma^2}{N}\left\{1-\frac{w}{\sqrt{N}}\times\frac{u}{\sqrt{N}}\right\},$$

u being a small number. But $u/\sqrt{N}$ will then be very small. Accordingly if n be small, the last term in the radical is sensibly smaller than the probable error of the first and we may read for the probable error of $m-M$ the expression:

$$\cdot 67449\sqrt{\frac{\Sigma^2-2\sigma^2}{N}+\frac{\sigma^2}{n}}.$$

Further the probable error of the difference or sum of Σ^2 and σ^2 is of the order of $\frac{2\sigma^2}{\sqrt{2n}}$ and thus to a first approximation we might put in the smaller term or first term $\sigma^2=\Sigma^2$. There results:

$$\cdot 67449\sqrt{\frac{\sigma^2}{n}-\frac{\Sigma^2}{N}}.$$

In other words, when the number of a sub-sample is very small, the probable error of $m-M$ approaches $\cdot 67449\sqrt{\frac{\sigma^2}{n}-\frac{\Sigma^2}{N}}$ and not $\cdot 67449\sqrt{\frac{\sigma^2}{n}+\frac{\Sigma^2}{N}}$. Our only excuse for using the latter form would be the negligibility altogether of the term Σ^2/N. In which case it would be better *à priori* to adopt the value $\cdot 67449\sqrt{\sigma^2/n}$. It will be clear therefore that the value frequently adopted is not justified when a sub-sample is tested against a general sample. The proper method seems to be to compare: $m-M$ with $\cdot 67449\sqrt{\frac{\sigma^2}{n}-\frac{2\sigma-\Sigma^2}{N}-\frac{n(M-m)^2}{N(N-n)}}$.

Now let it be reasonable to suppose a quantity significant when it is β times its standard deviation, or $\beta/\cdot 67449$ times its probable error, then we have for significance test:

$$m-M>\beta\sqrt{\frac{\sigma^2}{n}-\frac{2\sigma^2-\Sigma^2}{N}-\frac{n(M-m)^2}{N(N-n)}}.$$

Or:

$$m-M>\beta\sqrt{\frac{\sigma^2}{n}-\frac{2\sigma^2-\Sigma^2}{N}}\Big/\sqrt{1+\frac{\beta^2 n}{N(N-n)}};$$

and this is true whatever be the magnitudes of N and n. If it be said that the right-hand side is always less than $\beta\sqrt{\frac{\sigma^2}{n}+\frac{\Sigma^2}{N}}$, and that accordingly significance cannot have been asserted to exist, where it is not existent, this is perfectly true. But there is another side to this fact, too often forgotten. No samples suffice to demonstrate the absolute absence of differentiation; the statistician can only say: Relatively to the size of my samples, I find no significant differentiation. It may after all be there and would be demonstrated if the samples were tenfold as large. The absence of significance *relatively to* the size of the samples is too often interpreted by the casual reader as a denial of all differentiation, and this may be disastrous. Hence if the statistician using too large a value of the probable error errs on the side of safety, when he asserts significant differentiation for certain cases A, B, C, ..., but that he has not found it for E, F, G, ..., this may strengthen his demonstration in the first cases, but it weakens any influence as to non-significance in the latter cases.

Using the above formula it may be that a considerable number of cases, for which no proof of significant differentiation has been given,—and which have been taken accordingly as having no differentiation,—can now be demonstrated to have significant differentiation. And this appears of some importance.

Several other cases of probable error tests of significance deserve reconsideration, and I hope to find time to publish my notes on them shortly.

VI. Professor Ziegler and Galton's Law of Ancestral Inheritance.

In the published account (Jena, 1905) of the lecture on "Die Vererbungslehre in der Biologie" delivered by Professor Ziegler before the "XXII Congress für innere Medizin" the following footnote occurs:

"Da die grosselterlichen Anteile bei den einzelnen Enkeln nicht gleichmässig sind, so kann auch das von Galton formulierte Vererbungsgesetz nicht richtig sein. Es lautet so: Die Veranlagung eines Kindes setzt sich in folgende Weise aus den Vererbungsanlagen seiner Vorfahren zusammen; von den Eltern 50 prozent, von den Grosseltern 25 prozent, von den Urgrosseltern 25 prozent u.s.w.

F. Galton, *Natural Inheritance*, London, Macmillan, 1889.

Ders., The average Contribution of each several Ancestor to the total Heritage of the Offspring. *Proceedings of the Royal Society of London*, Vol. LXI. pp. 401—413, 1897."

If Professor Ziegler had read with understanding even the title of the second of the two works that he mentions, he would have seen that the Law of Ancestral Inheritance formulated by Galton makes no statement whatsoever concerning the relative shares of each several ancestor in any single case. Thus the question as to whether all the grandchildren of one particular grandparent receive the same or different contributions from him towards their total heritage has no bearing whatsoever on this law.

It is unnecessary in the pages of *Biometrika* to dwell further on this point, but perhaps one may be permitted to express some surprise that a man of Professor Ziegler's standing, in a lecture on heredity, in which space is found to enlarge on unproved and unproveable theories concerning chromasomes, should relegate to a footnote, and there completely misrepresent, such an important contribution to the subject as Galton's Law of Ancestral Inheritance.

EDGAR SCHUSTER.

VII. Variazione ed Omotiposi nelle infiorescenze di Cichorium Intybus L.

DAL DR FERNANDO DE HELGUERO, Roma.

Nella presente nota si studia la *Variazione* del numero dei fiori nelle infiorescenze di Cichorium Intybus L. e la *Omotiposi*, cioè la correlazione esistente fra le infiorescenze della stessa pianta.

Il materiale consta di 1000 infiorescenze raccolte durante il mese di Agosto 1905 a S. Leucio (Provincia di Caserta, Italia), appartenenti a 624 piante diverse. Questo materiale forma oggetto di due studi distinti, il primo riguardante la Variazione del carattere in esame, il secondo la Omotiposi.

1. *Variazione.*

Le 1000 infiorescenze sono state divise in tre gruppi a seconda che la pianta che le portava presentava o no altre infiorescenze. Il primo gruppo riguarda piante con una sola infiorescenza,

il secondo comprende le infiorescenze portate da piante con 2 infiorescenze, il terzo le infiorescenze portate da piante che ne avevano 3 od un numero maggiore :

N° dei fiori	Infiorescenze			Totale
	1° Gruppo	2° Gruppo	3° Gruppo	
8	2	1	1	4
9	7	5	9	21
10	28	13	14	55
11	107	80	72	259
12	126	98	86	310
13	84	76	73	233
14	27	16	47	90
15	7	7	8	22
16	1	3	1	5
17	—	1	—	1
Totale	389	300	311	1000

Questi gruppi danno i seguenti parametri :

	M	σ	$100\sigma/M$
1° Gruppo ...	11·931	1·2262	10·28
2° Gruppo ...	12·070	1·2484	10·34
3° Gruppo ...	12·206	1·3409	10·98
Totale	12·056	1·2716	10·54

Si vede dalla tabella che le infiorescenze appartenenti a piante più vicine al massimo di fioritura (con più fiori) hanno una media più elevata.

Questo è confermato dalle medie parziali dei varî lotti corrispondenti alle diverse raccolte delle infiorescenze. Le piante furono raccolte in 5 diverse volte durante il mese di Agosto e perciò nel periodo decrescente della fioritura : Ecco le medie parziali :

	Medie
1° Lotto	12·235
2° Lotto	12·321
3° Lotto	11·945
4° Lotto	11·905
5° Lotto	11·810.

Studiamo il poligono empirico di frequenza per l'intiero gruppo delle 1000 infiorescenze.

Si trova $\mu_2 = 1{\cdot}6169$, $\beta_1 = {\cdot}01252$,

$\mu_3 = {\cdot}2300$, $\beta_2 = 3{\cdot}44728$,

$\mu_4 = 9{\cdot}012$, $\sigma + 3\beta_1 - 2\beta_2 = -{\cdot}857$.

E la curva normale sarebbe :

$$y = 313{\cdot}74 e^{-\frac{(x-12{\cdot}056)^2}{3{\cdot}23372}}.$$

Ecco la tabella dei valori calcolati y confrontati cogli empirici y' :

x	y'	y	$y'-y$
7	—	·1	− ·1
8	4	1·9	+ 2·1
9	21	17·5	+ 3·5
10	55	84·9	−29·9
11	259	222·3	+36·7
12	310	313·4	− 3·4
13	233	238·2	− 5·2
14	90	97·6	− 7·6
15	22	21·5	+ ·5
16	5	2·6	+ 2·4
17	1	—	+ 1

L'area racchiusa fra i due poligoni calcolata col metodo di Duncker è del 3·45 °/₀. La rappresentazione è perciò soddisfaciente*. La curva è tracciata nella figura 1°.

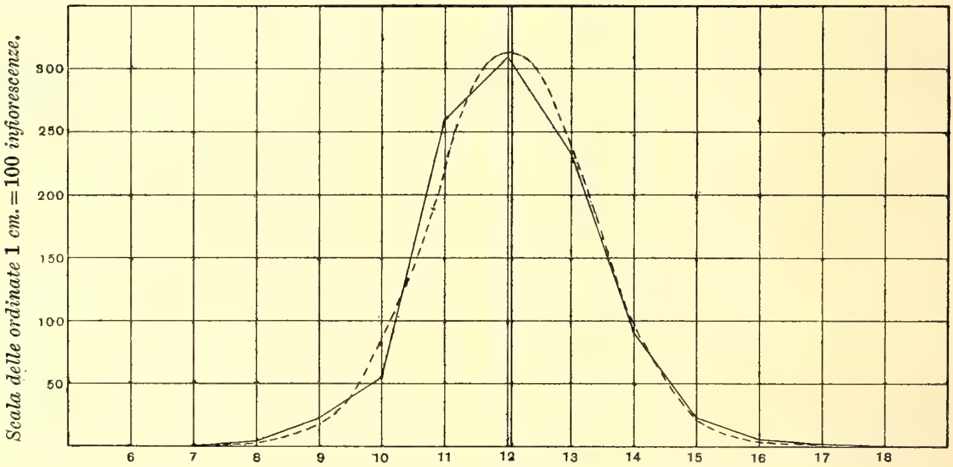


FIG. 1. Variazione del *Cichorium Intybus* L. (1000 infiorescenze.)

——— Poligono empirico.

– – – – – Curva normale.

$$\text{Equazione } y = 313{\cdot}74 e^{-\frac{(x-12{\cdot}065)^2}{3{\cdot}23372}}.$$

Riguardo alla Variazione noi poniamo le seguenti conclusioni :

1°. La *moda* nella Variazione del numero dei fiori nelle infiorescenze di *Cichorium Intybus* L. è 12 : perciò non un numero della serie del Fibonacci.

2°. La Variazione è normale coi parametri

$$M = 12{\cdot}056, \qquad \sigma = 1{\cdot}2716, \qquad \frac{100\sigma}{M} = 10{\cdot}54.$$

[* $\sqrt{\beta_1}$ is 2·1 and $\beta_2 - 3$ is 4·3 times the probable error, the distribution therefore probably differs significantly from the normal curve. Further, $\chi^2 = 20$ about, and $P = {\cdot}02$, or the odds are about 50 to 1 against such divergence from normality. EDS.]

3°. Nelle piante più vicine al massimo di fioritura la media è più elevata che nelle altre: riguardo alla variabilità non possiamo asserir nulla per quanto le cifre esposte nelle tabelle lascino dei sospetti che anche essa sia maggiore.

2. *Omotiposi.*

Per lo studio della Omotiposi non si deve che seguire le norme date dal Prof. Pearson nella memoria: "On the principle of Homotyposis etc., Part I, Homotyposis in the vegetable Kingdom," *Phil. Trans. of the R. Soc.* A, Vol. 197, pp. 285–379, memoria del più grande valore biologico e fondamentale in queste ricerche.

Il modo di trattare i dati è del tutto identico a quello della "fraternal inheritance."

Le nostre 624 piante appaiono così distinte a seconda del numero di infiorescenze che portavano al momento della raccolta:

piante con	1	sola infiorescenza	389
„	2	infiorescenze	150
„	3	„	50
„	4	„	20
„	5	„	11
„	6	„	2
„	7	„	2
		Totale	624

Le coppie di infiorescenze delle piante aventi 2 sole infiorescenze danno la seguente tavola di correlazione, resa simmetrica:

Tavola di correlazione per le piante aventi 2 infiorescenze.

	8	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	Totale
8	—	—	1	—	—	—	—	—	—	—	1
9	—	2	—	2	—	—	1	—	—	—	5
10	1	—	—	6	2	3	1	—	—	—	13
11	—	2	6	34	33	4	1	—	—	—	80
12	—	—	2	33	34	29	—	—	—	—	98
13	—	—	3	4	29	34	6	—	—	—	76
14	—	1	1	1	—	6	4	3	—	—	16
15	—	—	—	—	—	—	3	4	—	—	7
16	—	—	—	—	—	—	—	—	2	1	3
17	—	—	—	—	—	—	—	—	1	—	1
Totale	1	5	13	80	98	76	16	7	3	1	300

Media 12·07 ; $\sigma = 1{\cdot}2484$.

Si trova $\rho = {\cdot}5915$.

Si sono poi utilizzate le piante aventi più di due infiorescenze, considerando ogni pianta tante volte quante sono le coppie che si posson formare colle sue infiorescenze prese due a due. Per esempio, una pianta con 7 infiorescenze figura per $\frac{7 \times 6}{2} = 21$ piante distinte.

In tal modo con tutte le piante aventi più di una infiorescenza si è fatta la tavola :

Tavola di correlazione per tutte le piante aventi più di una infiorescenza.

	8	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	Totale
8	—	1	1	1	2	—	—	—	—	—	5
9	1	2	2	15	10	1	2	—	—	—	33
10	1	2	8	19	11	4	1	—	—	—	46
11	1	15	19	134	90	18	1	—	—	—	278
12	2	10	11	90	114	97	9	4	—	—	337
13	—	1	4	18	97	122	53	2	—	—	297
14	—	2	1	1	9	53	96	10	—	—	172
15	—	—	—	—	4	2	10	10	3	—	29
16	—	—	—	—	—	—	—	3	2	1	6
17	—	—	—	—	—	—	—	—	1	—	1
Totale	5	33	46	278	337	297	172	29	6	1	1204

$M = 12{\cdot}2226$; $\sigma = 1{\cdot}3536$.

Si trova $\rho = {\cdot}6130$.

I risultati concordanti delle due tavole ci permettono di enunciare la conclusione evitando le obbiezioni che ad esse singolarmente potrebbero farsi : alla prima, di basarsi sopra un numero troppo scarso di coppie, alla seconda, di dare un' eccessiva importanza alle piante con molte infiorescenze.

Dobbiamo ora confrontare la variabilità delle singole piante colla variabilità generale : ma ciò non ci è possibile direttamente per il numero troppo scarso di infiorescenze portate da ciascuna pianta.

Perciò ho seguito invece il metodo del Prof. Pearson calcolando la deviazione normale di ciò che egli chiama un "array," un gruppo, limitandomi alle piante portanti 2 sole infiorescenze.

Ho perciò raggruppato tutte le piante di cui una infiorescenza ha un numero fisso m di fiori ed ho calcolato la deviazione normale delle altre infiorescenze di questo gruppo di piante. Ho calcolato così σ per $m = 10$, 11, 12, 13 e 14 ed ho fatto la media ponderale di questi valori : ho ottenuto così come variazione normale di un gruppo $\sigma = {\cdot}9258$.

Il rapporto percentuale di questo valore alla deviazione normale dell' intiera popolazione mi dà la *variazione percentuale* : essa è uguale a 72·81.

Enunciamo allora le conclusioni :

1°. L'indice di correlazione per le infiorescenze di *Cichorium Intybus L.* prodotte dalla stessa pianta è circa ·6.

2°. La correlazione è un po' maggiore per gli individui aventi più infiorescenze, cioè più vicini al massimo di fioritura, che per gli altri.

3°. La variazione percentuale di un *gruppo* rispetto a tutte le infiorescenze è 72·81.

Si presenterebbe ora il problema della legge di variazione (se normale o no) delle infiorescenze prodotte dalla stessa pianta. Io non ho potuto fare ricerche sul Cichorium Intybus per la scarsità delle infiorescenze che si trovano sopra ogni singola pianta : ho potuto invece studiare per questo riguardo l' *Aster chinensis L.* e per l' analogia dell' argomento credo opportuno dare qui la statistica di 1326 infiorescenze raccolte sopra un' *unica* pianta colossale verso la metà del Maggio 1904 a Ferentino (Roma).

Ecco la statistica di cui il diagramma è tracciato nella Figura 2 :

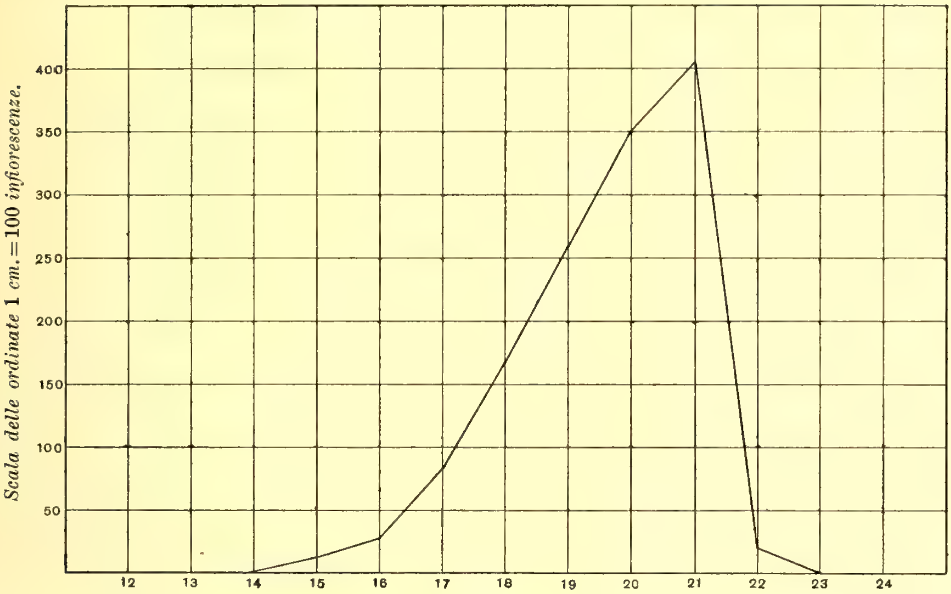


FIG. 2. Variazione dell' *Aster chinensis* L. (1326 infiorescenze.)

Nº di fiori ligulari.	Infiorescenze.
15	13
16	26
17	83
18	167
19	257
20	350
21	404
22	21
Totale	1326

La media è a 19·57164. È notevole il massimo a 21 numero della serie del Fibonacci.

La curva è decisamente abnormale, asimmetrica ; in fatti i parametri

$$\mu_2 = +\ 2\cdot00807,$$
$$\mu_3 = -\ 2\cdot28508,$$
$$\mu_4 = +12\cdot82515,$$

da cui $\sigma = 1\cdot41706$, $\beta_1 = +\cdot64487$, $\beta_2 = +3\cdot18057$, $\sigma + 3\beta_1 - 2\beta_2 = +1\cdot57347$,

conducono ad una curva del Tipo I colla asimmetria

$$A = \cdot81803.$$

VIII. The Calculation of the Probable Errors of Certain Constants of the Normal Curve.

By RAYMOND PEARL.

Anything which serves to lighten the labour of computation incident to biometric investigations is very welcome. On this account I venture to call attention to a point in which the "Tables for Facilitating the Computation of Probable Errors," recently published by Miss Winifred Gibson[*] will be found very useful.

It has been shown by Pearson[†] that in order to determine whether a given frequency distribution deviates sensibly from the normal or Gaussian law, it is necessary to know the probable errors for the normal curve of the following constants: the skewness, $\sqrt{\beta_1}$, $\beta_2 - 3$ the kurtosis and the "modal divergence." The formula for the probable error of the skewness, when n is the total number of individuals, is

$$\text{P.E.}_{\text{Sk}} = \cdot 6744898 \sqrt{\frac{3}{2n}}.$$

In a recently published note[‡] I pointed out the fact that, after having calculated the value of this expression for any given n, in order to obtain the probable errors of $\sqrt{\beta_1}$, $\beta_2 - 3$ and the "modal divergence" for the same distribution it was merely necessary to multiply the calculated value successively by 2, by 4 and by σ (i.e. the standard deviation of the distribution). We have then only to find an easy way of getting the value of the expression

$$\cdot 6744898 \sqrt{\frac{3}{2n}},$$

in order to make the whole process of testing any distribution for normality very simple indeed.

It is clear that we may write

$$\cdot 6744898 \sqrt{\frac{3}{2n}} = \cdot 6744898 K \sqrt{\frac{1}{n}} = \frac{\cdot 6744898}{\sqrt{n}} K = \chi_1 K,$$

where
$$K = \sqrt{\frac{3}{2}} = 1 \cdot 2247449\,\S,$$

and χ_1 is the χ_1 of Miss Gibson's Table I.

Therefore to test the approach to normality of any distribution we have merely to perform the following operations:

(i) Look out χ_1 for the given n from Miss Gibson's tables and multiply it by the factor 1·2247449, using as many places of decimals as necessary. This gives the probable error of the skewness for the normal curve.

(ii) Multiply the result by 2, which gives the probable error of $\sqrt{\beta_1}$ for the normal curve; multiply this result again by 2, and so obtain the probable error of $\beta_2 - 3$; finally multiply the probable error of the skewness by the σ of the distribution and obtain in this way the probable error of the modal divergence.

The relative divergence from zero of the skewness, $\sqrt{\beta_1}$, $\beta_2 - 3$ and the distance from mean to mode in comparison with their probable errors, measures the probability that the given distribution does not follow the normal or Gaussian law.

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[*] *Biometrika*, Vol. IV. pp. 385—393.

[†] *Biometrika*, Vol. IV. pp. 169—212, and elsewhere.

[‡] *Science*, N. S. Vol. XXII. p. 802.

[§] From Barlow's Tables.

IX. On the Probable Error of Mean-Square Contingency.

BY JOHN BLAKEMAN AND KARL PEARSON.

Let there be any contingency table and n_p be the total frequency in the pth row, n_q in the qth column, n_{pq} the frequency of the constituent common to the pth row and qth column, N the total frequency dealt with in the table. Then it is known* that the total mean square contingency ϕ^2 of the table is given by:

$$\phi^2 = \frac{1}{N} S_{pq} \left\{ \frac{\left(n_{pq} - \frac{n_p n_q}{N}\right)^2}{\frac{n_p n_q}{N}} \right\}, \quad \text{.............. (i)}$$

the sum being for all values of p and q.

Let ϕ^2_{pq} be the contribution to ϕ^2 of the p, q constituent frequency, i.e.

$$\phi^2_{pq} = \frac{1}{N} \frac{\left(n_{pq} - \frac{n_p n_q}{N}\right)^2}{\frac{n_p n_q}{N}} = \frac{n^2_{pq}}{n_p n_q} - \frac{2n_{pq}}{N} + \frac{n_p n_q}{N^2}. \quad \text{.............. (ii)}$$

Let $\phi_p{}^2$ be the contribution to ϕ^2 from a single row, and $\phi_q{}^2$ from a single column, i.e.

$$\phi_p{}^2 = S_q \phi^2_{pq} = S_q \left(\frac{n^2_{pq}}{n_p n_q}\right) - \frac{2S_q(n_{pq})}{N} + \frac{n_p}{N^2} S_q(n_q)$$

$$= S_q \left(\frac{n^2_{pq}}{n_p n_q}\right) - 2\frac{n_p}{N} + \frac{n_p}{N}$$

since $\quad S_q(n_{pq}) = n_p$ and $S_q(n_q) = N$.

Thus: $\quad \phi_p{}^2 = S_q\left(\frac{n^2_{pq}}{n_p n_q}\right) - \frac{n_p}{N},$

and similarly: $\quad \phi_q{}^2 = S_p\left(\frac{n^2_{pq}}{n_p n_q}\right) - \frac{n_q}{N}. \quad \text{.............. (iii)}$

It follows that: $\quad \phi^2 = S_p(\phi_p{}^2) = S_q(\phi_q{}^2) = S_{pq}\left(\frac{n^2_{pq}}{n_p n_q}\right) - 1. \quad \text{.............. (iv)}$

Let us write $\quad u_{pq} = \frac{n^2_{pq}}{n_p n_q}. \quad \text{.............. (v)}$

Then: $\quad 1 + \phi^2 = S_{pq}(u_{pq}). \quad \text{.............. (vi)}$

We shall now proceed to find the probable error of u_{pq}. We state the following preliminary propositions†, where σ denotes the standard deviation of random sampling:

$$\sigma^2_{n_{pq}} = n_{pq}\left(1 - \frac{n_{pq}}{N}\right), \quad \text{.............. (vii)}$$

$$\sigma^2_{n_p} = n_p\left(1 - \frac{n_p}{N}\right), \quad \text{.............. (viii)}$$

$$\sigma^2_{n_q} = n_q\left(1 - \frac{n_q}{N}\right), \quad \text{.............. (ix)}$$

$$\sigma_{n_p}\sigma_{n_q}R_{n_p n_q} = n_{pq} - \frac{n_p n_q}{N}, \quad \text{.............. (x)}$$

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* *Drapers' Research Memoirs, Biometric Series*, I. On the Theory of Contingency, etc., p. 6. Dulau & Co.

† *Drapers' Research Memoirs, Biometric Series*, II. On the Theory of Skew Correlation, etc., pp. 11—17. Dulau & Co.

$$\sigma_{n_p}\sigma_{n_{p'}}R_{n_p n_{p'}} = -\frac{n_p n_{p'}}{N}, \quad \text{.................................(xi)}$$

$$\sigma_{n_q}\sigma_{n_{q'}}R_{n_q n_{q'}} = -\frac{n_q n_{q'}}{N}, \quad \text{.................................(xii)}$$

$$\sigma_{n_{pq}}\sigma_{n_{p'q'}}R_{n_{pq} n_{p'q'}} = -\frac{n_{pq} n_{p'q'}}{N}, \quad \text{.................................(xiii)}$$

$$\sigma_{n_{pq}}\sigma_{n_{pq'}}R_{n_{pq} n_{pq'}} = -\frac{n_{pq} n_{pq'}}{N}, \quad \text{.................................(xiv)}$$

$$\sigma_{n_{pq}}\sigma_{n_{p'q}}R_{n_{pq} n_{p'q}} = -\frac{n_{pq} n_{p'q}}{N}, \quad \text{.................................(xv)}$$

$$\sigma_{n_p}\sigma_{n_{p'q}}R_{n_p n_{p'q}} = -\frac{n_p n_{p'q}}{N}, \quad \text{.................................(xvi)}$$

$$\sigma_{n_q}\sigma_{n_{pq'}}R_{n_q n_{pq'}} = -\frac{n_q n_{pq'}}{N}, \quad \text{.................................(xvii)}$$

$$\sigma_{n_p}\sigma_{n_{pq}}R_{n_p n_{pq}} = n_{pq}\left(1-\frac{n_p}{N}\right), \quad \text{.................................(xviii)}$$

$$\sigma_{n_q}\sigma_{n_{pq}}R_{n_q n_{pq}} = n_{pq}\left(1-\frac{n_q}{N}\right), \quad \text{.................................(xix)}$$

where throughout p and p' and q and q' denote different columns and rows, and R is a correlation coefficient between subscript frequencies. Taking logarithmic differentials of (v), i.e. treating the deviations of random sampling as of differential order as is usually done,

$$\frac{\delta u_{pq}}{u_{pq}} = \frac{2\delta n_{pq}}{n_{pq}} - \frac{\delta n_p}{n_p} - \frac{\delta n_q}{n_q}. \quad \text{.................................(xx)}$$

Then squaring, summing and dividing by the number of random samples:

$$\frac{\sigma^2{}_{u_{pq}}}{u^2{}_{pq}} = 4\frac{\sigma^2{}_{n_{pq}}}{n^2{}_{pq}} + \frac{\sigma^2{}_{n_p}}{n_p{}^2} + \frac{\sigma^2{}_{n_q}}{n_q{}^2} + 2\frac{\sigma_{n_p}\sigma_{n_q}R_{n_p n_q}}{n_p n_q} - 4\frac{\sigma_{n_{pq}}\sigma_{n_p}R_{n_{pq} n_p}}{n_{pq} n_p} - 4\frac{\sigma_{n_{pq}}\sigma_{n_q}R_{n_{pq} n_q}}{n_{pq} n_q}.$$

Whence using (vii), (viii), (ix), (x), (xviii) and (xix) we find

$$\sigma^2{}_{u_{pq}} = u^2{}_{pq}\left(\frac{4}{n_{pq}} - \frac{3}{n_p} - \frac{3}{n_q} + \frac{2n_{pq}}{n_p n_q}\right). \quad \text{.................................(xxi)}$$

We have next to find the correlation of deviations in u_{pq} and $u_{p'q'}$ due to random sampling. Three cases can occur according as p and q are equal or unequal to p' and q' respectively. We have by multiplying (xx) by a similar form:

$$\begin{aligned}\frac{\sigma_{u_{pq}}\sigma_{u_{p'q'}}R_{u_{pq} u_{p'q'}}}{u_{pq}u_{p'q'}} &= 4\frac{\sigma_{n_{pq}}\sigma_{n_{p'q'}}R_{n_{pq} n_{p'q'}}}{n_{pq}n_{p'q'}} - 2\frac{\sigma_{n_{pq}}\sigma_{n_{p'}}R_{n_{pq} n_{p'}}}{n_{pq}n_{p'}} \\ &\quad - 2\frac{\sigma_{n_{pq}}\sigma_{n_{q'}}R_{n_{pq} n_{q'}}}{n_{pq}n_{q'}} - 2\frac{\sigma_{n_p}\sigma_{n_{p'q'}}R_{n_p n_{p'q'}}}{n_p n_{p'q'}} \\ &\quad + \frac{\sigma_{n_p}\sigma_{n_{p'}}R_{n_p n_{p'}}}{n_p n_{p'}} + \frac{\sigma_{n_p}\sigma_{n_{q'}}R_{n_p n_{q'}}}{n_p n_{q'}} \\ &\quad - 2\frac{\sigma_{n_q}\sigma_{n_{p'q'}}R_{n_q n_{p'q'}}}{n_q n_{p'q'}} + \frac{\sigma_{n_q}\sigma_{n_{p'}}R_{n_q n_{p'}}}{n_q n_{p'}} \\ &\quad + \frac{\sigma_{n_q}\sigma_{n_{q'}}R_{n_q n_{q'}}}{n_q n_{q'}}. \quad \text{.................................(xxii)}\end{aligned}$$

Whence using (xiii), (xvi), (xix), (xi), (x) and (xvii) we have :

$$\sigma_{u_{pq}}\sigma_{u_{p'q'}}R_{u_{pq}u_{p'q'}}=u_{pq}\,u_{p'q'}\left(\frac{n_{pq'}}{n_p n_{q'}}+\frac{n_{p'q}}{n_{p'}n_q}\right). \qquad \ldots\ldots\ldots\ldots\ldots\ldots(\text{xxiii})$$

Taking $p=p'$ in (xxii) and using (xiv), (xviii), (xvii), (xi), (x) and (xii) we find :

$$\sigma_{u_{pq}}\sigma_{u_{pq'}}R_{u_{pq}u_{pq'}}=u_{pq}u_{pq'}\left(\frac{n_{pq}}{n_p n_q}+\frac{n_{pq'}}{n_p n_{q'}}-\frac{3}{n_p}\right). \qquad \ldots\ldots\ldots\ldots\ldots\ldots(\text{xxiv})$$

Similarly :

$$\sigma_{u_{pq}}\sigma_{u_{p'q}}R_{u_{pq}u_{p'q}}=u_{pq}\,u_{p'q}\left(\frac{n_{pq}}{n_p n_q}+\frac{n_{p'q}}{n_{p'}n_q}-\frac{3}{n_q}\right). \qquad \ldots\ldots\ldots\ldots\ldots\ldots(\text{xxv})$$

Turning back to (vi) and taking differentials, we have :

$$2\phi\delta\phi=S_{pq}(\delta u_{pq}).$$

Square, sum and divide by the number of random samples, and we find:

$$\begin{aligned}4\phi^2\sigma_\phi{}^2=S_{pq}(\sigma^2{}_{u_{pq}})&+2\Sigma_1(\sigma_{u_{pq}}\sigma_{u_{p'q'}}R_{u_{pq}u_{p'q'}})\\&+2\Sigma_2(\sigma_{u_{pq}}\sigma_{u_{p'q}}R_{u_{pq}u_{p'q}})\\&+2\Sigma_3(\sigma_{u_{pq}}\sigma_{u_{pq'}}R_{u_{pq}u_{pq'}}),\end{aligned}$$

where Σ_1 denotes a summation for all unlike values of p, p', q and q' ; Σ_2 for all like values of q and unlike of p and p' ; Σ_3 for all like values of p, unlike of q and q'.

Substituting from (xxi), (xxiii), (xxiv) and (xxv) we have :

$$\begin{aligned}4\phi^2\sigma_\phi{}^2=\ &S_{pq}\left\{u^2{}_{pq}\left(\frac{4}{n_{pq}}-\frac{3}{n_p}-\frac{3}{n_q}+\frac{2n_{pq}}{n_p n_q}\right)\right\}\\&+2\Sigma_1\left\{u_{pq}\,u_{p'q'}\left(\frac{n_{pq'}}{n_p n_{q'}}+\frac{n_{p'q}}{n_{p'}n_q}\right)\right\}\\&+2\Sigma_2\left\{u_{pq}\,u_{p'q}\left(\frac{n_{pq}}{n_p n_q}+\frac{n_{p'q}}{n_{p'}n_q}-\frac{3}{n_q}\right)\right\}\\&+2\Sigma_3\left\{u_{pq}u_{pq'}\left(\frac{n_{pq}}{n_p n_q}+\frac{n_{pq'}}{n_p n_{q'}}-\frac{3}{n_p}\right)\right\}. \qquad \ldots\ldots\ldots\ldots\ldots(\text{xxvi})\end{aligned}$$

We will consider the parts of this in order. Let ψ_{pq} be taken $=\dfrac{1}{N}\left(n_{pq}-\dfrac{n_p n_q}{N}\right)$ = contribution from any constituent to the mean contingency. Then

$$\phi^2{}_{pq}=N^2\psi^2{}_{pq}/n_p n_q. \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(\text{xxvii})$$

Hence

$$\phi^2=N^2S_{pq}\left(\frac{\psi^2{}_{pq}}{n_p n_q}\right). \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(\text{xxviii})$$

Again

$$\begin{aligned}S_{pq}\left(\frac{u^2{}_{pq}}{n_{pq}}\right)=S_{pq}\left(\frac{n^3{}_{pq}}{n_p{}^2n_q{}^2}\right)&=S_{pq}\left\{\frac{\left(N\psi_{pq}+\frac{n_p n_q}{N}\right)^3}{n_p{}^2n_q{}^2}\right\}\\&=N^3S_{pq}\left(\frac{\psi^3{}_{pq}}{n_p{}^2n_q{}^2}\right)+3NS_{pq}\left(\frac{\psi^2{}_{pq}}{n_p n_q}\right)+\frac{1}{N}, \qquad \ldots\ldots\ldots\ldots\ldots\ldots(\text{xxix})\end{aligned}$$

remembering that $S_{pq}(\psi_{pq})=0$ and $S_{pq}(n_p n_q)=N^2$. Next consider

$$\begin{aligned}S_{pq}\left(\frac{u^2{}_{pq}}{n_q}\right)+2\Sigma_2\left(\frac{u_{pq}u_{p'q}}{n_q}\right)&=S_q\left\{\frac{S_p(u_{pq})\times S_p(u_{pq})}{n_q}\right\}\\&=S_q\left\{\left(\phi_q{}^2+\frac{n_q}{N}\right)^2\Big/n_q\right\}\\&=S_q\left(\frac{\phi_q{}^4}{n_q}\right)+\frac{2\phi^2}{N}+\frac{1}{N}. \qquad \ldots\ldots\ldots\ldots\ldots\ldots(\text{xxx})\end{aligned}$$

Similarly:
$$S_{pq}\left(\frac{u^2{}_{pq}}{n_p}\right)+2\Sigma_3\left(\frac{u_{pq}u_{pq'}}{n_p}\right)=S_p\left(\frac{\phi_p{}^4}{n_p}\right)+\frac{2\phi^2}{N}+\frac{1}{N}. \quad \text{................(xxxi)}$$

Lastly:
$$\begin{aligned}2S_{pq}&\left(\frac{u^2{}_{pq}\,n_{pq}}{n_p n_q}\right)+2\Sigma_1(u_{pq}u_{p'q'})\left(\frac{n_{pq'}}{n_p n_{q'}}+\frac{n_{p'q}}{n_{p'}n_q}\right)\\
&+2\Sigma_2(u_{pq}u_{p'q})\left(\frac{n_{pq}}{n_p n_q}+\frac{n_{p'q}}{n_{p'}n_q}\right)+2\Sigma_3(u_{pq}u_{pq'})\left(\frac{n_{pq}}{n_p n_q}+\frac{n_{pq'}}{n_p n_{q'}}\right)\\
&=2S_{pq}\{S_{q'}(u_{pq'})\,S_{p'}(u_{p'q})\,n_{pq}/n_p n_q\}\\
&=2S_{pq}\left\{\left(\phi_p{}^2+\frac{n_p}{N}\right)\left(\phi_q{}^2+\frac{n_q}{N}\right)\frac{n_{pq}}{n_p n_q}\right\}\\
&=2S_{pq}\left(\phi_p{}^2\,\phi_q{}^2\,\frac{n_{pq}}{n_p n_q}\right)+\frac{4\phi^2}{N}+\frac{2}{N}. \quad \text{.......................................(xxxii)}\end{aligned}$$

Then substituting from (xxix), (xxx), (xxxi) and (xxxii) in (xxvi) we have:
$$\begin{aligned}4\phi^2\sigma_\phi{}^2= &\;4N^3S_{pq}(\psi^3{}_{pq}/n_p{}^2n_q{}^2)+12\phi^2/N+4/N\\
&-3S_q\left(\frac{\phi_q{}^4}{n_q}\right)-3S_p\left(\frac{\phi_p{}^4}{n_p}\right)-12\phi^2/N-6/N\\
&+2S_{pq}\left(\phi_p{}^2\phi_q{}^2\,\frac{n_{pq}}{n_p n_q}\right)+4\phi^2/N+2/N\\
= &\;4\phi^2/N+4N^3S_{pq}\{\psi^3{}_{pq}/n_p{}^2n_q{}^2\}\\
&+2S_{pq}\frac{(\phi_p{}^2\phi_q{}^2)}{N}-3S_q\left(\frac{\phi_q{}^4}{n_q}\right)-3S_p\left(\frac{\phi_p{}^4}{n_p}\right)\\
&+2NS_{pq}\left(\phi_p{}^2\,\phi_q{}^2\,\frac{\psi_{pq}}{n_p n_q}\right). \quad \text{..................................(xxxiii)}\end{aligned}$$

When the contingencies, mean and mean squared, approach zero, the terms of the third, fourth and fifth orders may be neglected as compared with that of the second order and we find

$$\sigma_\phi{}^2=\frac{1}{N}, \quad \text{or} \quad \sigma_\phi=\frac{1}{\sqrt{N}}. \quad \text{.................................(xxxiv)}$$

But if C be the coefficient of mean squared contingency:

$$C=\sqrt{\frac{\phi^2}{1+\phi^2}},$$

and accordingly
$$\sigma_C=\frac{\sigma_\phi}{(1+\phi^2)^{\frac{3}{2}}}=(1-C^2)^{\frac{3}{2}}\,\sigma_\phi. \quad \text{..............................(xxxv)}$$

Hence the probable error of C

$$=\cdot 67449\,(1-C^2)^{\frac{3}{2}}\,\sigma_\phi,$$

and in the particular case of no contingency

$$=\frac{\cdot 67449}{\sqrt{N}} \text{ by (xxxiv).}$$

Hence unless a coefficient of mean squared contingency be two or three times this value, we have no evidence that the quantities under discussion can be considered as contingent on each other.

The general expression for σ_ϕ in (xxxiii) can be dealt with in several ways. It might be thought that ψ_{pq} being of changing sign, the cubic terms as well as those of the fifth order in ψ_{pq} would be small; but this is not our experience in actual application. Terms will occur in which n_{pq} is very large as compared with $n_p n_q/N$ owing to the existence of a few isolated units in outlying compartments, and it by no means follows that the second term is less than the first, or the sixth term less than the third. We have not succeeded in getting any appreciation of "negligible terms" when the contingency is not very small. The whole formula may be written:

$$\phi^2\sigma_{\phi}{}^2 = S_{pq}\left(\phi^2{}_{pq}\frac{n_{pq}}{n_p n_q}\right) + \tfrac{1}{2}S_{pq}\left(\phi_p{}^2\phi_q{}^2\frac{n_{pq}}{n_p n_q}\right) - \tfrac{3}{4}S_p\left(\frac{\phi_p{}^4}{n_p}\right) - \tfrac{3}{4}S_q\left(\frac{\phi_q{}^4}{n_q}\right). \quad \text{...(xxxvi)}$$

If we endeavour to get some idea of the general magnitude of this expression, by evaluating it for a normal correlation surface we find, for infinitesimal groupings, that the last two terms become infinite if r does not lie between $-1/\sqrt{3}$ to $+1/\sqrt{3}$ and the first term becomes infinite when r does not lie between $-1/2$ to $+1/2$. In fact in such cases we *seem* to reach indefinitely large probable errors. We doubt, however, the justice of this view and believe it merely signifies that with *indefinitely fine* grouping beyond a certain range of values of r, the assumption that the errors of random sampling may be treated as differentials is incorrect, and thus our process of reaching (xxxvi) is no longer legitimate when applied to such normal distributions. The whole matter, however, deserves careful investigation from the theoretical standpoint. Even from the practical side the error in any constituent due to random sampling must be at least unity, and accordingly if the theoretical value of the constituent be only a few units or a fraction even of a unit $\delta n_{pq}/n_{pq}$ is not necessarily a small quantity. We ought accordingly to provide in practice for a contingency grouping which leaves no constituent to consist of but a few units, if we wish to justify our fundamental assumption in determining the probable error.

In actual practice with fairly coarse grouping and not replacing the summations by integrations, the value for σ_{ϕ} will always be finite, for we make no summation where either n_p or n_q are zero, i.e. we do not as in using the normal surface extend our distribution all over space. For the cases in which we have tried it (xxxvi) then gives reasonable results, and we will now indicate how the calculations can be made fairly briefly.

In the accompanying table we have the contingency between Intelligence and Handwriting in schoolgirls. The columns correspond to grades of intelligence, the rows to grades of handwriting. The first number of each constituent group is the actual frequency in the total of 1801 girls with the characteristics of that group. The reciprocal of 1801 is $555{,}247/10^9$. This is put on the calculator and the column of row totals multiplied by it, with the result n_q/N put under each row total; each one of these is now put on the machine in succession and multiplied by the series of column totals n_p; we thus obtain $n_p n_q/N$, which is registered as the second number in each constituent. The difference of the first and second number of each constituent with due regard to sign is $N\psi_{pq}$ the constituent contingency. This is registered as the third number in the constituent. The square of this—taken from Barlow's tables—and divided by the second number is $N\phi^2{}_{pq}$, or N times the mean square contingency contribution of each constituent. This is the fourth number registered in the constituents. The sum of these fourth numbers for each row gives $N\phi_q{}^2$, and for each column $N\phi_p{}^2$. These are registered in the column and row beyond "totals." Adding up this column or row, we have

$$S_q(N\phi_q{}^2) = S_p(N\phi_p{}^2) = 172{\cdot}52 = N\phi^2, \text{ hence } \phi^2 = {\cdot}09580 \text{ and } C = \sqrt{\phi^2/(1+\phi^2)} = {\cdot}2957.$$

This is the coefficient of mean squared contingency between handwriting and intelligence, and is our standard method of finding C. So far all the work is usual and necessary. Now square from Barlow the column of $N\phi_q{}^2$ and the row of $N\phi_p{}^2$; we obtain the column and row of $N^2\phi_q{}^4$ and $N^2\phi_p{}^4$. Divide these by their respective column and row total frequencies and we have the numbers given underneath $N^2\phi_q{}^4$ and $N^2\phi_p{}^4$, or $N^2\phi_q{}^4/n_q$ and $N^2\phi_p{}^4/n_p$ respectively. Adding up these column numbers and row numbers we find on division by N

$$\frac{1}{N}S\left(\frac{N^2\phi_q{}^4}{n_q}\right) = {\cdot}05758, \quad \frac{1}{N}S\left(\frac{N^2\phi_p{}^4}{n_p}\right) = {\cdot}03199,$$

values registered on the table. These are two of the sums needed for (xxxvi). If the distribution were *normal* and the group ranges *infinitesimal* these should be equal. They clearly differ widely. Next divide $N\phi_q{}^2$ by 1801, i.e. multiply these quantities by the reciprocal, placed on the machine. The results are tabled beneath the values of $N\phi_q{}^2$, or these are $\phi_q{}^2$. Put each $\phi_q{}^2$ on the calculator and multiply it by the row $N\phi_p{}^2$. These products are given as the fifth figure in each constituent. The sixth figure is $Nn_{pq}/(n_p n_q)$ or is the result of dividing the first figure by the second. The seventh figure is the sixth multiplied by the fourth or

$$= N\phi^2{}_{pq} \times Nn_{pq}/(n_p n_q) = N^2\phi^2{}_{pq}\, n_{pq}/(n_p n_q),$$

and the eighth is the sixth figure multiplied by the fifth

$$= \phi_p{}^2\, N\phi_q{}^2 \times N\frac{n_{pq}}{n_p n_q} = N^2\phi_p{}^2\phi_q{}^2 n_{pq}/(n_p n_q).$$

These are added up for each row and placed as the third and fourth figures in the $N^2\phi_q{}^4$ column: added up for the column and divided by N, they give

$$S_{pq}\{N\phi^2{}_{pq} n_{pq}/(n_p n_q)\} \quad = \cdot 2444{,}586,$$
$$S_{pq}\{N\phi_p{}^2\phi_q{}^2 n_{pq}/(n_p n_q)\} = \cdot 014{,}0827,$$

which determine the first and second sums in the value of $\phi^2\sigma_\phi{}^2$. But

$$S_{pq}\{N\phi^2{}_{pq} n_{pq}/(n_p n_q)\} = S_{pq}(\phi^2{}_{pq}) + S_{pq}\left(N^2\phi^2{}_{pq}\frac{\psi_{pq}}{n_p n_q}\right)$$
$$= (\cdot 09580) + N^4 S_{pq}\{\psi^3{}_{pq}/(n_p{}^2 n_q{}^2)\}:$$

whence it follows that $\quad N^3 S_{pq}\{\psi^3{}_{pq}/(n_p{}^2 n_q{}^2)\} = \cdot 14865/N,$

while $\quad \phi^2/N = S_{pq}(\phi^2{}_{pq})/N \ = \cdot 09580/N$

is *less* in value. Thus the cubic terms in the contingency are more important than the square, and cannot in this case be neglected compared to them in the present case.

Again $\quad S_{pq}\{N\phi_p{}^2\phi_q{}^2 n_{pq}/(n_p n_q)\} = \phi^4 + N^2 S_{pq}\left(\dfrac{\phi_p{}^2\phi_q{}^2\psi_{pq}}{n_p n_q}\right):$

whence $\quad NS_{pq}\{\phi_p{}^2\phi_q{}^2\psi_{pq}/(n_p n_q)\} = \dfrac{\cdot 0140827 - (\cdot 09580)^2}{N}$

$$= \cdot 00490/N,$$

while $\quad S_{pq}(\phi_p{}^2\phi_q{}^2)/N = \phi^4/N = \cdot 00918/N.$

Thus the fifth order term is only one-half roughly of the fourth order term and is not in this case negligible with regard to it. It is clearly the very dull, very bad handwriters whose excess so emphasises these terms. In this, as in other cases, we cannot accordingly neglect any of the terms contributory to the probable error and we have by (xxxiii):

$$\phi^2\sigma_\phi{}^2 = \frac{1}{N}\{\cdot 24446 + \cdot 00704 - \cdot 06718\} = \frac{\cdot 18432}{N},$$

or, $\quad \sigma_\phi{}^2 = 1\cdot 9240/N = \cdot 001068, \text{ and } \sigma_\phi = \cdot 0327$ *.

But $\quad \sigma_C = \sigma_\phi/(1+\phi^2)^{\frac{3}{2}}, \text{ by (xxxv)}$

$$= \left\{\frac{\cdot 001068}{1\cdot 315813}\right\}^{\frac{1}{2}} = \cdot 0285.$$

Hence the probable error of $C = \cdot 0192$.

The probable error of C, if it were found from the coefficient of correlation, would be $\cdot 67449(1-r^2)/\sqrt{N} = \cdot 0139$. Thus the coefficient as found by mean squared contingency is rather more subject to error than the coefficient of correlation, say in the ratio of 4 to 3. The rule given in Pearson's memoir† appears, to judge by this case, to err on the side of asserting no significance, where after all it may exist.

The actual arithmetic of determining the probable error is not so laborious as might have been anticipated.

The coefficient of mean contingency obtained from the diagram in the memoir just cited is ·31, so that it differs from $C = \cdot 30$ by less than the probable error.

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* Probable Error of $\phi^2 = \cdot 67449 \times 2\phi\sigma_\phi = \cdot 0042$.

† *Drapers' Research Memoirs: Biometric Series*, I., p. 18. Dulau & Co.

Contingency between Handwriting and Intelligence in Girls.

Writing	Quick Intelligent	Intelligent	Slow Intelligent	Slow	Slow Dull	Very Dull	Totals n_q	$N\phi_q^2$ & ϕ_q^2	$N^2\phi_q^4$, & $N^2\phi_q^4/n_q$
Very Good	38 17·88 +20·12 22·64 ·761 2·125 48·11 1·617	47 44·11 +2·89 ·19 ·392 1·066 ·20 ·418	30 38·34 −8·34 1·81 ·153 ·782 1·42 ·120	6 16·30 −10·30 6·51 ·616 ·368 2·40 ·227	4 6·86 −2·86 1·19 ·619 ·583 ·69 ·361	1 2·52 −1·52 ·92 ·645 ·397 ·37 ·256	126 ·069961 $=n_q/N$ $=N\psi_{pq}$ $=N\phi^2_{pq}$ $=N\phi_p^2\phi_q^2$ $=Nn_{pq}/n_pn_q$ $=N^2\phi^2_{pq}n_{pq}/n_pn_q$ $=N^2\phi_p^2\phi_q^2n_{pq}/n_pn_q$	— — — 33·26 ·018468 — — —	— — — 1106·23 8·780 53·19 = * 2·999 = †
Good	115 93·28 +21·72 5·06 ·864 1·233 6·24 1·065	277 230·18 +46·82 9·52 ·445 1·203 11·45 ·535	185 200·06 −15·06 1·13 ·174 ·925 1·05 ·161	55·5 85·06 −29·56 10·27 ·700 ·652 6·70 ·456	19 35·78 −16·78 7·87 ·703 ·531 4·18 ·373	6 13·14 −7·14 3·88 ·732 ·457 1·77 ·335	657·5 ·365075 — — — — — —	— — — 37·73 ·020966 — — —	— — — 1423·55 2·165 31·39 2·925
Moderate	67 101·08 −34·08 11·49 ·486 ·663 7·62 ·322	231·5 249·43 −17·93 1·29 ·251 ·928 1·20 ·233	244·5 216·80 +27·70 3·54 ·098 1·128 3·99 ·111	112·5 92·18 +20·32 4·48 ·394 1·220 5·47 ·481	43 38·77 +4·23 ·46 ·396 1·109 ·51 ·439	14 14·24 −·24 ·00 ·412 ·983 ·00 ·405	712·5 ·395614 — — — — — —	— — — 21·26 ·011805 — — —	— — — 451·99 ·634 18·79 1·991
Poor	26·5 34·62 −8·12 1·90 ·665 ·765 1·45 ·509	62 85·42 −23·42 6·42 ·342 ·726 4·66 ·248	75·5 74·24 +1·26 ·02 ·134 1·017 ·02 ·136	48 31·57 +16·43 8·55 ·539 1·520 13·00 ·819	21 13·28 +7·72 4·49 ·541 1·581 7·10 ·855	11 4·88 +6·12 7·68 ·564 2·254 17·31 1·271	244 ·135480 — — — — — —	— — — 29·06 ·016135 — — —	— — — 844·48 3·461 43·54 3·838
Bad	7 6·38 +·62 ·06 ·333 1·097 ·07 ·365	11 15·75 −4·75 1·43 ·172 ·698 1·00 ·120	9 13·69 −4·69 1·61 ·067 ·657 1·06 ·044	10 5·82 +4·18 3·00 ·270 1·718 5·15 ·885	7 2·45 +4·55 8·45 ·271 2·857 24·14 ·774	1 0·90 +·10 ·01 ·282 1·111 ·01 ·313	45 ·024986 — — — — — —	— — — 14·56 ·008084 — — —	— — — 211·99 4·711 31·43 2·501
Very Bad	2 2·30 −·30 ·04 ·838 ·870 ·03 ·729	2 5·66 −3·66 2·37 ·432 ·353 ·84 ·152	4 4·92 −·92 ·17 ·168 ·813 ·14 ·137	1 2·09 −1·09 ·57 ·679 ·478 ·27 ·325	4 0·88 +3·12 11·06 ·682 4·545 50·27 3·100	3 0·32 +2·68 22·44 ·711 9·375 210·38 6·666	16 ·008984 — — — — — —	— — — 36·65 ·020350 — — —	— — — 1343·22 83·951 261·93 = ‡ 11·109 = §
Totals n_p	255·5	630·5	548	233	98	36	1801 ·555247/10³	— —	$\frac{1}{N}S_q\left(\frac{N^2\phi_q^4}{n_q}\right)$ = ·05758
$N\phi_p^2$ $N^2\phi_p^4$ $N^2\phi_p^4/n_p$	41·19 1696·62 6·640	21·22 450·29 ·714	8·28 68·56 ·125	33·38 1114·22 4·782	33·52 1123·59 11·465	34·93 1220·10 33·892	$\frac{1}{N}S_p\left(\frac{N^2\phi_p^4}{n_p}\right)$ = ·03199	172·52 $=N\phi^2$ $\phi^2=$ ·09580 ± ·0042	C = ·2957 ± ·0192

The first four numbers in each constituent are those required in the usual calculation of mean square contingency; the second set of four are those required to determine its probable error. The actual arithmetical work if we need the coefficient of mean square *and* its probable error is thus just doubled.

* $S_p\{N^2\phi^2_{pq}n_{pq}/(n_pn_q)\}$. † $S_p\{N^2\phi_p^2\phi_q^2n_{pq}/(n_pn_q)\}$.

‡ $S_{pq}\{\phi^2_{pq}n_{pq}/(n_pn_q)\}=\frac{1}{N}$ (·2444586). § $S_{pq}\{\phi_p^2\phi_q^2n_{pq}/(n_pn_q)\}=\frac{1}{N}$ (·014083).

X. On a Coefficient of Class Heterogeneity or Divergence.

By KARL PEARSON, F.R.S.

(1) In considering the sub-groups of a population—especially in dealing with local races in man, animals or plants—a problem of the following character has not infrequently arisen: It is found that a sub-class, for example a local sample, differs considerably from the general population. This divergence may have any magnitude upwards from the probable limits of random sampling. We require some coefficient which will express by a single number the relative divergence from the general population of each sub-class or local group. For example, we take the frequency of alternative characteristics of the local population and find these are represented by certain percentages in the general population; we know also the percentages in the sub-group. We can, of course, take the difference of each individual percentage and of the general population percentage and find the probable error of this difference, but this gives us a series of numbers, and not a single measure of the general heterogeneity of the group. These numbers may also belong to correlated characters, and when one number marks a great excess in percentage we may expect a great defect in a second percentage for this very reason. But this makes the weight to be given to such a complex system of numbers extremely difficult to estimate.

The necessity for some general coefficient of class heterogeneity was impressed upon me, while discussing with Mr J. F. Tocher his reduction of the Anthropometrical Surveys recently made of the inmates of Scottish Asylums and of the children in Scottish Schools. It was needful to find a single number, which would measure local heterogeneity, or the divergence from a random sample of the general population in a series of characters of the local population. The number chosen must be such (i) that allowance is made for the size of the sample, (ii) that the numbers for different sub-groups or localities are strictly comparable, and (iii) that we have some idea as to the size of its probable error. Following up a suggestion of Mr Tocher I have reached what I think is a workable *coefficient of divergence*, which may be useful in dealing with local race problems.

Suppose a contingency table formed in which the columns are marked by the alternative characters under consideration and each row is peculiar to a sub-group or district. Thus let the characters be α, β, γ, δ ... and the sub-groups a, b, c, d, e .... We have the table:

TABLE I.

	α	β	γ	δ	ϵ	η	—	ω	Totals
a	$n_{a\alpha}$	$n_{a\beta}$	$n_{a\gamma}$	$n_{a\delta}$	$n_{a\epsilon}$	$n_{a\eta}$	—	$n_{a\omega}$	n_a
b	$n_{b\alpha}$	$n_{b\beta}$	$n_{b\gamma}$	$n_{b\delta}$	$n_{b\epsilon}$	$n_{b\eta}$	—	$n_{b\omega}$	n_b
c	$n_{c\alpha}$	$n_{c\beta}$	$n_{c\gamma}$	$n_{c\delta}$	$n_{c\epsilon}$	$n_{c\eta}$	—	$n_{c\omega}$	n_c
d	$n_{d\alpha}$	$n_{d\beta}$	$n_{d\gamma}$	$n_{d\delta}$	$n_{d\epsilon}$	$n_{d\eta}$	—	$n_{d\omega}$	n_d
e	$n_{e\alpha}$	$n_{e\beta}$	$n_{e\gamma}$	$n_{e\delta}$	$n_{e\epsilon}$	$n_{e\eta}$	—	$n_{e\omega}$	n_e
—	—	—	—	—	—	—	—	—	—
z	$n_{z\alpha}$	$n_{z\beta}$	$n_{z\gamma}$	$n_{z\delta}$	$n_{z\epsilon}$	$n_{z\eta}$	—	$n_{z\omega}$	n_z
Totals	n_α	n_β	n_γ	n_δ	n_ϵ	n_η	—	n_ω	N

Here the first column gives all the districts or sub-groups which form the total population The distribution of the alternative characters in the total population is given in the last row, while the last column gives the total frequency of each sub-group. Any number such as $n_{i\gamma}$

is the frequency of the alternative character γ in the sub-group or district i. For example $\alpha, \beta, \gamma \ldots$ may be the alternative hair colours in a country of which the different districts are $a, b, c, d \ldots z$. Such tables arise over and over again in anthropometric surveys. If now each sub-group or district were a random sample of the general population, then the coefficient of contingency of this table—say the coefficient of mean square contingency—should within the limits of probable error be zero. We have thus a table of the contingency between geographical sub-districts and the alternative characteristics. And the greater this contingency the more markedly are the sub-groups divergent from random samples of the general population. In other words the population is geographically* heterogeneous. Accordingly if we take the same or nearly the same set of characters for two populations and about the same number of sub-groups or districts, such tables as the above give by their coefficients of contingency a reasonable measure of inter-racial comparison. The population or race with the highest coefficient of contingency is clearly the most heterogeneous. The relative heterogeneity of Prussians, Swedes, Italians, Scottish and, perhaps, English could, I think, be now determined in this manner from published data for at least hair and eye colour.

But we require not only an inter-racial coefficient of heterogeneity, but an intra-racial coefficient, which will measure the relative heterogeneity of the various groups. To reach this, pick out any district or sub-class b and oppose it to the rest of the population in a table of the following kind:

TABLE II.

	α	β	γ	δ	ϵ	η	—	ω	Totals
b Rest	$n_{b\alpha}$ $n_\alpha - n_{b\alpha}$	$n_{b\beta}$ $n_\beta - n_{b\beta}$	$n_{b\gamma}$ $n_\gamma - n_{c\gamma}$	$n_{b\delta}$ $n_\delta - n_{b\delta}$	$n_{b\epsilon}$ $n_\epsilon - n_{c\epsilon}$	$n_{b\eta}$ $n_\eta - n_{b\eta}$	— —	$n_{b\omega}$ $n_\omega - n_{b\omega}$	n_b $N - n_b$
Totals	n_α	n_β	n_γ	n_δ	n_ϵ	n_η	—	n_ω	N

This is also a contingency table, of a very contracted character it is true, but none the less absolutely valid, if it be only used for relative purposes. Let the coefficient of mean square contingency of this table be found and be C_b, then the relative values of C_a, C_b, C_d, etc. will be measures of the class and local differences, or what we may call intra-racial differences. I suggest these C's as the coefficients we are seeking. We will now investigate the nature of C_b. Let $\chi_b{}^2$ be the mean square contingency, then:

$$\chi_b{}^2 = \frac{1}{N} \sum_\alpha^\omega \left\{ \frac{\left(n_{b\alpha} - \dfrac{n_\alpha n_b}{N}\right)^2}{\dfrac{n_\alpha n_b}{N}} + \frac{\left(n_\alpha - n_{b\alpha} - \dfrac{n_\alpha (N - n_b)}{N}\right)^2}{\dfrac{n_\alpha (N - n_b)}{N}} \right\}$$

$$= \frac{1}{N} \sum_\alpha^\omega \left\{ \frac{\left(n_{b\alpha} - \dfrac{n_\alpha n_b}{N}\right)^2}{\dfrac{n_\alpha n_b}{N}} \left(1 + \frac{n_b}{N - n_b}\right) \right\}$$

$$= \frac{1}{N - n_b} \sum_\alpha^\omega \left\{ \frac{\left(n_{b\alpha} - \dfrac{n_\alpha n_b}{N}\right)^2}{\dfrac{n_\alpha n_b}{N}} \right\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{(i)}.$$

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* The sub-groups need not of course be 'geographical'; they might be economically, socially, or otherwise differentiated.

Now if ϕ^2 be the mean square contingency of Table I. and if $\phi_b{}^2$ be the contribution to it of the b row we have:

$$\phi^2 = \phi_a{}^2 + \phi_b{}^2 + \phi_c{}^2 + \dots + \phi_z{}^2$$

where

$$\phi_b{}^2 = \frac{1}{N} \overset{\omega}{\underset{\alpha}{S}} \left\{ \frac{\left(n_{b\alpha} - \frac{n_\alpha n_b}{N} \right)^2}{\frac{n_\alpha n_b}{N}} \right\} \text{ ....(ii).}$$

Or, we have:

$$\chi_b{}^2 = \frac{N}{N - n_b} \phi_b{}^2.$$

But:

$$C_b = \sqrt{\frac{\chi_b{}^2}{1 + \phi_b{}^2}} = \sqrt{\frac{\phi_b{}^2}{1 - \frac{n_b}{N} + \phi_b{}^2}}. \text{ ....(iii).}$$

Thus we have the following rule:

Start with Table I. and determine the contributions $\phi_a{}^2$, $\phi_b{}^2$, $\phi_c{}^2 \dots \phi_z{}^2$ of each sub-group or locality to the total mean square contingency of this table. Then C_a, C_b, … C_z determined as above are the "coefficients of divergence" of the respective sub-groups or classes or localities from the general population, and their relative magnitudes measure the relative divergency of such groups or localities.

(2) If the Class b were, for example, merely a random sample of the general population, we should have $\phi_b{}^2 = 0$ and $C_b = 0$. It becomes accordingly of importance to determine the probable error of C_b on the assumption that Class b is a random sample. If C_b differs from zero by several times its probable error, the divergence of the Class is almost certainly significant. The general expression for the probable error of a coefficient of mean square contingency has been dealt with in another paper*. In the notation of that paper

$$\phi^2 \sigma_{\phi^2} = S_{pq} \left(\phi^2{}_{pq} \frac{n_{pq}}{n_p n_q} \right) + \tfrac{1}{2} S_{pq} \left(\phi_p{}^2 \phi_q{}^2 \frac{n_{pq}}{n_p n_q} \right) - \tfrac{3}{4} S_p \left(\frac{\phi_p{}^4}{n_p} \right) - \tfrac{3}{4} S_q \left(\frac{\phi_q{}^4}{n_q} \right) \text{.........(iv).}$$

ϕ^2 will now be $\chi_b{}^2$ and we have to perform the summations for the two rowed table, Table II, above. The q summation will be from α to ω and the p summation for the two rows of our table. I take the terms in order.

(i) $S_{pq} \left(\phi^2{}_{pq} \frac{n_{pq}}{n_p n_q} \right)$. This in our present notation stands for

$$\overset{\omega}{\underset{\alpha}{S}} \left(\phi^2{}_{b\alpha} \frac{n_{b\alpha}}{n_b n_\alpha} \right) + \frac{n_b}{N - n_b} \overset{\omega}{\underset{\alpha}{S}} \left(\phi^2{}_{b\alpha} \frac{n_\alpha - n_{b\alpha}}{n_\alpha (N - n_b)} \right),$$

since $\phi^2{}_{pq}$ for any constituent of the second row is by the line above Equation (i) $= \frac{n_b}{N - n_b} \phi^2{}_{b\alpha}$, where $\phi^2{}_{b\alpha}$ is the contribution to the mean square contingency from the first row constituent immediately above. Let us write $\nu_b = n_b/(N - n_b)$. Then we have, if we write

$$\tau_b{}^2 = \overset{\omega}{\underset{\alpha}{S}} \{ \phi^2{}_{b\alpha} n_{b\alpha} / (n_b n_\alpha) \} \text{ ....(v),}$$

$$S_{pq} \left(\phi^2{}_{pq} \frac{n_{pq}}{n_p n_q} \right) = \tau_b{}^2 (1 - \nu_b{}^2) + \nu_b{}^2 \phi_b{}^2 / n_b \text{ ....(vi).}$$

(ii) $\tfrac{1}{2} S_{pq} \left(\phi_p{}^2 \phi_q{}^2 \frac{n_{pq}}{n_p n_q} \right)$. For the first line $\phi_q{}^2 = \phi_b{}^2$ and for the second line $= \nu_b \phi_b{}^2$. Hence the value of this, if we remember that $\phi_p^2 = \phi^2_{ba} + \nu_b \phi^2_{ba}$ for the a column, is given by

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* "On the Probable Error of Mean Square Contingency," see Equation (xxxvi), *Biometrika*, Vol. v. p. 195.

$$\tfrac{1}{2}\phi_b^2 \overset{\omega}{\underset{a}{S}} \left\{(1+\nu_b)\,\phi^2_{ba}\frac{n_{ba}}{n_b n_a} + \nu_b(1+\nu_b)\,\phi^2_{ba}\frac{n_a - n_{ba}}{n_a(N-n_b)}\right\}$$

$$= \tfrac{1}{2}(1+\nu_b)(1-\nu_b^2)\,\phi_b^2\,\tau_b^2 + \tfrac{1}{2}(1+\nu_b)\,\nu_b^2\phi_b^2/n_b \ldots\ldots\ldots\ldots\text{(vii)}.$$

(iii) $$\tfrac{3}{4}S_p\left(\frac{\phi_p^4}{n_p}\right) = \tfrac{3}{4}(1+\nu_b)^2 \overset{\omega}{\underset{a}{S}}\left(\frac{\phi^4_{ba}}{n_a}\right) = \tfrac{3}{4}(1+\nu_b)^2\,\omega_b^4 \ldots\ldots\ldots\ldots\text{(viii)},$$

if $$\omega_b^4 = \overset{\omega}{\underset{a}{S}}\left(\frac{\phi^4_{ba}}{n_a}\right) \ldots\ldots\ldots\ldots\text{(ix)}.$$

(iv) $\tfrac{3}{4}S_q\left(\frac{\phi_q^4}{n_q}\right)$. This since the summation is for only two rows is given by

$$\tfrac{3}{4}\left(\frac{\phi_b^4}{n_b} + \nu_b^2\frac{\phi_b^4}{N-n_b}\right)$$

or $$\tfrac{3}{4}S_q\left(\frac{\phi_q^4}{n_q}\right) = \tfrac{3}{4}(1+\nu_b^3)\,\phi_b^4/n_b \ldots\ldots\ldots\ldots\text{(x)}.$$

Writing (vi), (vii), (viii) and (x) in (iv) we find :

$$\chi_b^2\sigma^2_{\chi_b} = \{\tau_b^2(1-\nu_b^2) + \nu_b^2\,\phi_b^2/n_b\}\,\{1 + \tfrac{1}{2}(1+\nu_b)\,\phi_b^2\} - \tfrac{3}{4}\left\{(1+\nu_b^3)\frac{\phi_b^4}{n_b} + (1+\nu_b)^2\,\omega_b^4\right\}.$$

But by the line above equation (iii) $\chi_b^2 = (1+\nu_b)\,\phi_b^2$. Hence :

$$\sigma^2_{\chi_b} = \frac{1}{n_b}\left\{\frac{\nu_b^2}{1+\nu_b} + \frac{n_b\tau_b^2}{\phi_b^2}(1-\nu_b)\right\}\{1 + \tfrac{1}{2}(1+\nu_b)\,\phi_b^2\}$$
$$- \frac{3}{4n_b}\left\{(1-\nu_b+\nu_b^2)\,\phi_b^2 + (1+\nu_b)\frac{n_b\omega_b^4}{\phi_b^2}\right\} \ldots\ldots\ldots\ldots\text{(xi)}.$$

This involves a knowledge of ϕ_b^2, τ_b^2 and ω_b^4. The first will have been found in determining the contingency coefficient of the entire table ; the second in determining its probable error, and the third only has to be specially calculated.

Finally we have*

$$\sigma_{C_b} = \{1 - C_b^2\}^{\frac{3}{2}}\,\sigma_{\chi_b} \ldots\ldots\ldots\ldots\text{(xii)}.$$

Or the

$$\text{Probable Error of } C_b = {\cdot}67449\,(1 - C_b^2)^{\frac{3}{2}}\,\sigma_{\chi_b}.$$

(3) I propose to illustrate this numerically on a table already largely worked out in the paper referred to above. It has been shown that handwriting is contingent in a certain degree on grade of intelligence. I propose to investigate which group of handwriters has a distribution of intelligence most markedly different from that of the general population, i.e. which is intellectually most heterogeneous. This is not in itself a problem of any importance but it will serve to illustrate the application of the above formulæ, and the numerical work needful for their evaluation. Turning to the table, p. 197, I extracted the results given in Table III. The only new quantities to be calculated are the values of

$$\omega_b^4 = \overset{\omega}{\underset{a}{S}}\left(\frac{\phi^4_{ba}}{n_a}\right) = \frac{1}{N^2}\overset{\omega}{\underset{a}{S}}\left(\frac{(N\phi^2_{ba})^2}{n_a}\right).$$

Now $N\phi^2_{ba}$ is the fourth number in each constituent of the table on p. 197. The squares of these from Barlow's Tables are the first number in each constituent of Table IV. ; n_a is given under the total at the foot and immediately above n_a, its reciprocal. These reciprocals placed successively on the calculator and multiplied by the first number in each column

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* *loc. cit.* p. 194.

TABLE III.

Handwriting	n_b	ν_b	$1+\nu_b{}^3$	$\phi_b{}^2$	$N\phi_b{}^2$	$N^2\tau_b{}^2$	$N^2\omega_b{}^4$	$\sigma\chi_b$	C_b	P.E. of C_b
Very Good	126	·0752	1·0004	·0185	32·26	53·19	2·232	·0321	·1395	·0210
Good ...	657·5	·5750	1·1901	·0210	37·73	31·39	1·749	·0239	·1787	·0154
Moderate ...	712·5	·6546	1·2805	·0118	21·26	18·79	·631	·0238	·1384	·0156
Poor ...	244	·1567	1·0038	·0161	29·06	43·54	2·237	·0296	·1354	·0194
Bad ...	45	·0256	1·0000	·0081	14·56	31·43	·776	·0367	·0907	·0244
Very Bad ...	16	·0090	1·0000	·0204	36·65	261·93	15·246	·0714	·1418	·0467

TABLE IV.

Intelligence.

Handwriting.	Quick Intelligent	Intelligent	Slow Intelligent	Slow	Slow Dull	Very Dull	$N^2\omega_b{}^4$
Very Good	512·57 2·006	·04 ·000	3·28 ·006	42·38 ·182	1·42 ·014	·85 ·024	2·232
Good ...	25·60 ·100	90·63 ·144	1·28 ·002	105·47 ·453	61·94 ·632	15·05 ·418	1·749
Moderate	132·02 ·517	1·66 ·003	12·53 ·023	20·07 ·086	·21 ·002	·00 ·000	·631
Poor ...	3·61 ·014	41·22 ·065	·00 ·000	73·10 ·314	20·16 ·206	58·98 1·638	2·237
Bad ...	·00 ·000	2·04 ·003	2·59 ·005	9·00 ·039	71·40 ·729	·00 ·000	·776
Very Bad	·00 ·000	5·62 ·009	·03 ·000	·32 ·001	122·32 1·248	503·55 13·988	15·246
Reciprocals Totals ...	·003914 255·5	·001586 630·5	·001825 548	·004292 233	·010204 98	·027778 36	·555247/10³ 1801

constituent give $(N\phi^2{}_{ba})^2/n_a$ which is recorded as the second number in each constituent. The sum of these for each row gives $N^2\omega_b{}^4$ recorded to the right and also in Table III., $\sigma^2\chi_b$ can now be found from the form

$$\sigma^2\chi_b=\frac{1}{N}\left[\left(\nu_b+\frac{N^2\tau_b{}^2}{N\phi_b{}^2}(1-\nu_b)\right)(1+\tfrac{1}{2}(1+\nu_b)\,\phi_b{}^2)-\tfrac{3}{4}\left(\frac{1+\nu_b{}^3}{\nu_b}\,\phi_b{}^2+(1+\nu_b)\frac{N^2\omega_b{}^4}{N\phi_b{}^2}\right)\right].$$

And again

$$C_b=\sqrt{\frac{\phi_b{}^2}{1-\dfrac{n_b}{N}+\phi_b{}^2}}=\sqrt{\frac{\phi_b{}^2}{1/(1+\nu_b)+\phi_b{}^2}}\text{ from (iii).}$$

These values are also recorded in Table III. Then σ_{C_b} was found from (xii) and so the probable error of C_b.

The values of C_b show us that the class of "Good" handwriters is most and that of "Bad" handwriters least divergent from the general population. The other four classes have values of C_b sensibly equal and equal to ·14. The "Good" handwriters have ·18 and the "Bad" ·09, and the question is whether these are significantly different from ·14, or from each other. The probable error of the difference is about ·03. It would therefore be reasonable to assume that "Good" and "Bad" handwriters do differ from each other, though it is less easy to assert marked difference from the community at large. On the whole it seems reasonable to suggest that in distribution of intelligence the "Good" handwriters are less like a random sample of the general girl population than "Bad" handwriters. In other words heterogeneity of intelligence is more marked in the class "Good" than in the class "Bad."

As I have said, the illustration is one of numerical method only and not of interest in itself. The special purpose of the present note is the suggestion of a coefficient which may be of value in the many cases in which we wish to compare the deviation of local samples of a population from the proportions exhibited by a general population.

XI. Inheritance in the Female Line of Size of Litter in Poland China Sows.

By G. M. ROMMEL, B.S.A., and E. F. PHILLIPS, Ph.D., United States Department of Agriculture, Washington, D.C.

From the data of the American Poland China Record, the authors determined the inheritance of the size of litters from mother to daughter, using 6145 litters farrowed in 1902. The methods were those commonly employed in statistical studies of heredity.

The tabulation of the sizes of litters from mothers and daughters and the determination of the coefficient of correlation (r) shows that there is an actual correlation between the size of litters of two successive generations, and the authors feel justified in concluding that size of litter is a character transmitted from mother to daughter. The coefficient of correlation for the five years is small (·06) but it is appreciable and consequently it would appear proved that by judicious selection of sows from large litters, the average for the breed may be increased.

Correlation in size of Litter of Poland China Sows between Mother (M) and Daughter (D). American Poland China Record.

Age of Daughters	Number of Cases	Mean M	Mean D	σ_M	σ_D	r	P. E. of r
1 Year ...	2010	7·908	6·6451	2·0764	1·7582	·1088	± ·0149
2 Years ...	2047	7·6927	7·5598	1·9818	1·9415	·0885	± ·0148
3 Years ...	1157	7·5809	7·8799	1·9615	2·0693	·0883	± ·0197
4 Years ...	606	7·6304	8·2821	1·9856	2·0661	·0379	± ·0274
5 Years ...	325	7·6738	8·4031	2·1001	2·1571	·0032	± ·0375
1—5 Years	6145	7·7349	7·4391	2·0202	2·0312	·0601	± ·0086

The decrease from ·1088 to practically zero (·0032) from the first to the fifth year does not necessarily mean that the inheritance of fecundity is lost as a sow grows older, but probably indicates that inheritance from the dam gradually plays relatively less and less of a part in the determination, while other factors, notably nutrition, play more. The correlation tables are given over page. This work is being followed with an investigation of the inheritance of size of litter through the male line and from the ancestors in the female line.

CORRELATION TABLES OF SIZE OF LITTERS OF SOWS WITH SIZE OF LITTERS IN WHICH DAMS WERE FARROWED. AMERICAN POLAND CHINA RECORD.—LITTERS OF 1902.

TABLE I. *Yearling Sows.*

Size of Litters of Yearling Sows.

Size of Litters in which Dams were Farrowed.	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	Totals
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	2	2	1	1	—	—	1	—	—	—	7
3	—	4	2	1	2	3	4	2	2	1	—	—	—	21
4	—	—	3	5	22	20	10	4	6	—	—	—	—	70
5	—	1	4	15	26	28	24	15	5	6	1	—	—	125
6	—	1	3	21	34	65	81	43	18	7	2	—	—	275
7	1	4	4	27	47	89	89	62	31	12	2	—	—	368
8	1	1	10	31	65	67	81	61	34	12	3	1	1	368
9	—	1	5	21	53	76	87	67	35	14	10	1	1	371
10	1	1	4	14	16	38	48	36	23	6	6	—	—	193
11	—	2	2	8	20	21	22	22	13	7	4	—	—	121
12	—	1	1	4	7	15	12	8	4	1	2	1	—	56
13	—	—	3	2	4	6	1	5	—	1	—	—	1	23
14	—	—	—	—	1	2	3	2	1	1	—	—	—	10
15	—	—	—	—	—	—	—	—	—	1	—	—	—	1
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	—	—	—	1	—	—	—	—	—	—	—	—	—	1
Totals	3	16	41	152	299	431	463	327	172	70	30	3	3	2010

TABLE II. *Two-Year-Old Sows.*

Size of Litters of Two-Year-Old Sows.

Size of Litters in which Dams were Farrowed.	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	Totals
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	1	—	—	1	2	—	1	—	—	—	—	—	5
3	—	—	—	2	4	2	2	4	6	2	—	—	1	—	—	23
4	—	—	3	4	3	10	14	10	12	2	3	1	1	1	—	64
5	—	—	3	6	10	33	34	36	27	6	6	2	—	—	1	164
6	1	2	7	15	26	52	70	68	36	27	8	4	1	—	—	317
7	—	2	5	10	25	71	86	84	59	32	12	2	2	1	—	391
8	—	7	4	15	36	55	95	78	64	32	11	6	4	1	—	408
9	1	2	2	8	20	36	61	65	70	33	20	4	1	1	—	324
10	—	—	1	5	14	30	33	45	23	14	15	6	1	—	—	187
11	—	2	1	2	7	4	21	21	15	13	7	2	—	—	1	96
12	—	—	2	1	4	10	9	9	2	4	3	1	—	—	—	45
13	—	—	—	—	1	3	2	3	4	1	1	—	—	—	—	15
14	—	—	—	—	—	—	3	1	1	1	1	—	1	—	—	8
Totals	2	15	28	69	150	306	431	426	319	168	87	28	12	4	2	2047

TABLE III. *Three-Year-Old Sows.*

Size of Litters of Three-Year-Old Sows.

Size of Litters in which Dams were Farrowed.	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	Totals
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	1	1	1	1	—	—	—	—	—	—	—	—	4
3	—	1	—	1	2	1	2	4	5	—	—	1	—	—	—	—	1	18
4	—	1	—	—	2	3	6	9	7	6	2	—	1	—	—	—	—	37
5	—	1	1	5	11	17	15	22	16	4	3	3	1	—	—	—	—	99
6	1	1	3	5	14	27	37	29	35	14	12	3	—	—	—	—	—	181
7	1	—	2	9	19	25	50	48	31	34	12	4	2	—	—	—	—	237
8	1	—	5	3	13	31	40	47	35	22	18	2	3	—	1	1	—	222
9	—	—	—	3	8	17	33	30	31	24	8	2	3	2	—	—	—	161
10	1	—	3	—	6	11	16	25	24	17	4	—	1	1	1	—	—	110
11	—	—	—	4	5	5	14	13	12	6	4	3	1	—	—	—	—	67
12	—	—	1	—	—	2	3	1	2	4	5	—	—	—	—	—	—	18
13	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1
14	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals	4	4	15	30	80	141	217	230	200	131	68	18	12	3	2	1	1	1157

TABLE IV. *Four-Year-Old Sows.*

Size of Litters of Four-Year-Old Sows.

Size of Litters in which Dams were Farrowed.	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	Totals
1	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	2
2	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	2
3	—	—	1	—	1	—	1	2	1	3	—	—	—	—	—	9
4	—	—	—	1	—	2	5	5	4	3	2	2	—	—	—	24
5	—	—	—	2	3	5	6	11	8	7	2	—	—	1	—	45
6	—	—	—	2	6	7	13	18	8	17	3	2	1	1	—	78
7	—	1	—	2	6	13	22	24	32	16	4	2	—	1	—	123
8	—	—	1	3	5	10	15	23	26	24	6	6	1	1	1	122
9	—	1	1	3	8	9	18	18	15	20	10	1	2	3	—	109
10	—	—	—	1	4	5	5	10	8	11	3	—	—	1	—	48
11	—	—	—	2	2	5	1	5	6	1	5	2	1	—	—	30
12	—	—	—	—	1	2	—	1	2	3	1	—	—	—	—	10
13	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	2
14	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	2
Totals	—	2	3	16	36	60	87	118	111	107	36	16	5	8	1	606

TABLE V. *Five-Year-Old Sows.*

Size of Litters of Five-Year-Old Sows.

Size of Litters in which Dams were Farrowed.	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	Totals
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1
3	—	—	—	—	1	—	—	1	2	—	—	—	—	—	—	4
4	—	—	—	—	—	2	1	2	3	2	—	—	—	—	1	11
5	—	—	—	—	1	3	3	6	6	4	2	2	—	—	—	27
6	—	1	1	1	4	8	4	10	6	8	7	1	1	2	—	54
7	—	—	—	1	1	8	12	10	13	11	6	1	3	—	—	66
8	—	—	—	2	3	3	11	14	10	4	3	3	—	—	—	53
9	—	2	—	2	4	3	8	11	12	6	4	2	—	—	—	54
10	—	—	—	1	—	4	3	5	4	3	3	2	1	1	—	27
11	—	—	—	—	—	1	3	2	2	4	1	—	—	—	—	13
12	—	—	—	—	—	—	1	2	1	—	—	—	1	—	—	5
13	—	—	—	—	1	—	1	1	1	1	2	—	1	—	—	8
14	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	2
Totals	—	3	1	7	15	32	48	64	61	43	28	12	7	3	1	325

TABLE VI. *All Litters,* 1902.

Size of Litters of Sows One to Five Years Old.

Size of Litters in which Dams were Farrowed.	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	Totals
1	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	2
2	—	—	—	3	2	2	3	3	2	3	—	1	—	—	—	—	—	19
3	—	5	3	4	10	6	9	13	16	6	—	1	1	—	—	—	1	75
4	—	1	6	10	27	37	36	30	32	13	7	3	2	1	1	—	—	206
5	—	2	8	28	51	86	82	90	62	27	14	7	1	1	1	—	—	460
6	2	5	14	44	84	159	205	168	103	73	32	10	3	3	—	—	—	905
7	2	7	11	49	98	206	259	228	166	105	36	9	7	2	—	—	—	1185
8	2	8	20	54	122	166	242	223	169	94	41	18	9	2	2	1	—	1173
9	1	6	8	37	93	141	207	191	163	97	52	10	7	6	—	—	—	1019
10	2	1	8	21	40	88	105	121	82	51	31	8	3	3	1	—	—	565
11	—	4	3	16	34	36	61	63	48	31	21	7	2	—	1	—	—	327
12	—	1	4	5	12	29	25	21	11	12	11	2	1	—	—	—	—	134
13	—	—	3	2	6	11	5	9	5	3	3	—	2	—	—	—	—	49
14	—	—	—	—	1	3	7	3	4	3	1	—	1	—	—	—	—	23
15	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1
16	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
17	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Totals	9	40	88	274	580	970	1246	1165	863	519	249	77	39	18	6	1	1	6145

NOTICES AND BIBLIOGRAPHY.

NOTICES.

1. Edgeworth, F. Y. *The Law of Error.* Transactions of the Cambridge Philosophical Society, 1905, Vol. xx. pp. 36—65 and 113—141.
2. ——. *The Generalised Law of Error, or Law of Great Numbers.* Journal of the Royal Statistical Society, 1906, Vol. lxix. pp. 497—539.
3. Charlier, C. V. L. *Ueber das Fehlergesetz.* Arkiv för Matematik, Astronomi och Fysik, Vol. ii. Stockholm, 1905.
4. ——. *Die zweite Form des Fehlergesetzes.* Ibid.
5. ——. *Ueber die Darstellung Willkürlicher Functionen.* Ibid.
6. ——. *Researches into the Theory of Probability.* Meddelanden från Lunds Astronomiska Observatorium, Serie ii. No. 4. Lund, 1906.

In (1) Professor Edgeworth, starting from various conditions, some of which he afterwards shows can be relaxed, gives four methods by which one can reach an "approximate expression of the frequency with which in the long run different values are assumed by a quantity which is dependent on a number of variable items or elements." These conditions are that the elements assume different values in random fashion and in the long run recur with a proportionate frequency capable of being represented by a single definite frequency curve; that the variations are independent of each other*; that the method of aggregation by which the elements are compounded is summation, etc. etc.

Professor Edgeworth first gives a method which consists of equating the t^{th} moment of the frequency with the same moment of the given locus. He then shows that the same curve can be reached by working on the lines followed by Professor Morgan Crofton and by the method originated by Laplace and developed by Poisson. He then gives confirmatory evidence by using Laplace's analysis with some of the conditions used by Crofton and inserts the fresh condition that if there be two or more magnitudes each fluctuating according to the law of error, then the sum of each must also fluctuate according to that law.

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* [The assumptions that the elementary cause-groups are independent and that the aggregate is obtained by summation have yet to be justified. In particular the first assumption is opposed to the basis of every determinantal theory of heredity, and accordingly the frequency distributions of characters, which result from the fusion and throwing out of chromasomes, i.e. characters in living organisms, are extremely unlikely to comply closely with Professor Edgeworth's form of frequency. I have repeatedly urged the necessity for considering contributions to the aggregate as *correlated*, i.e. the hypergeometrical as distinguished from the binomial form of series, as the basis of frequency distributions. The skew curves I have introduced proceed from the basis that the "contributory cause-groups" give contributions to the aggregate which are *correlated*. See *Biometrika*, Vol. iv. pp. 196, 203 *et seq.* K. P.]

The general form reached is written

$$e^{-\kappa_1 \frac{1}{3!}\left(\frac{d}{dx}\right)^3 + \kappa_2 \frac{1}{4!}\left(\frac{d}{dx}\right)^4 - \ldots + (-1)^t \frac{1}{(t+2)!}\left(\frac{d}{dx}\right)^{t+2}} \frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{x^2}{2\sigma}}$$

where $$\kappa_1{}^2 = \frac{\mu_3{}^2}{8\mu_2{}^3}; \qquad \kappa_2 = \frac{\mu_4 - 3\mu_2{}^2}{4\mu_2{}^2}; \text{ etc.}$$

If this form be rewritten as

$$F(x) = A_0\phi(x) + A_3\phi^{\text{iii}}(x) + A_4\phi^{\text{iv}}(x) + \ldots$$

where $$\phi(x) = \frac{1}{\sqrt{2\pi\sigma}} e^{-(x-b)^2/2\sigma}$$

it becomes the same as that called Type A by Dr Charlier in (3), (5) and (6) and it is also the same as that given by Dr Thiele in "Theory of Observations" (London, C. and E. Layton, 1903) p. 35. Charlier's method of reaching his form is by following Hagen's development of Laplace. The same writer also gives in (4), and considers more minutely in (5) and (6), the form (Type B) which he writes

$$F(x) = B_0\psi(x) + B_1\Delta\psi(x) + B_2\Delta^2\psi(x) + \ldots$$

where $$\psi(x) = \frac{e^{-\lambda}\sin \pi x}{\pi}\left[\frac{1}{x} - \frac{\lambda}{1!(x-1)} + \frac{\lambda^2}{2!(x-2)} \ldots\right].$$

This curve with a range limited in one direction is, we believe, new though Thiele has given a form very closely allied to it (*loc. cit.* p. 21).

Charlier uses the method of moments for fitting his curves, but though both Edgeworth and he do this, and their series finally take the same form, different graduation results will be reached owing to the index form being used in the one case and not in the other; the difference may, in some cases, be negligible but in others it becomes of more importance and we shall therefore refer to it later.

It will be noticed that in all cases it is proposed to use a series to describe the frequency distribution and there seem to us so many objections to this course in practice that it is well to take this opportunity of examining it. The objections to it are as follows:

(i) If one of the later coefficients has a large value the neglect of later terms of the series may involve a considerable error, while their inclusion demands the use of the higher moments which are untrustworthy owing to their large probable errors.

(ii) In some cases the series lead to negative frequencies, which is objectionable. This can often occur with Type A and is noticeable with Thiele's example (*loc. cit.* p. 50).

(iii) It is necessary to make successive graduations using an increasing number of terms in order to find how many terms of the series are required to give a satisfactory graduation.

(iv) As we cannot tell at the first how many terms to use, it is necessary to base the solution of the equations for finding the constants on integrations over the whole series from $-\infty$ to $+\infty$ and then neglect terms which may or may not be significant, or else to make successive trials with an increasing number of terms from equations formed from the actual number of terms used. The latter method would be better if the position of negative terms could be decided at the outset and if integration could be effected between any limits that might be indicated. This would however seem to be impossible and Charlier uses the former method; the objection does not apply to Edgeworth's series.

The effect of these objections in the case of Charlier's work is interesting as it is quite impossible to reproduce one of his frequency curves (the bi-modal curve, fig. 5 of (6)) statistically because the negative frequencies play so important a part in the series that if positive frequency only be taken (which is what would happen in practice) an entirely different curve is obtained. We are by no means satisfied that in such cases the integration for moments from $-\infty$ to $+\infty$ is sound because of the terms which must be omitted in practice, and we think the point deserves more consideration in the mathematical treatment of (5) than it receives. It will perhaps be advisable to give the details of the curve given by Charlier to which our objections refer, and show our failure to reproduce it. The equation to the curve of fig. 5 is

$$F(x) = N[\phi_0(x) - \cdot 1\, \phi_4(x)],$$

where

$$\phi_n(x) = \sigma^{n+1} \phi^n(x),$$

and the ordinates corresponding are given in the first row of the following statement in which, as the curves are symmetrical, the last few terms are omitted.

From Charlier's fig. 5 of (6)	− ·0021	− ·0060	− ·0089	+ ·0095	+ ·0810	+ ·1999	+ ·2904	+ ·2971	+ ·2792	+ ·2971
Above graduated ...	− ·0012	− ·0016	+ ·0035	+ ·0269	+ ·0832	+ ·1695	+ ·2572	+ ·3155	+ ·3333	+ ·3155

The moments were calculated about the mean from the figures given but the negative frequencies which Charlier does not give in his diagram and which are meaningless in practical work, were neglected. The values were as follows:

Second moment $= 4 \cdot 7089$
Third „ $=$ zero
Fourth „ $= 46 \cdot 987$
$\sigma = 2 \cdot 1700$

and the equation is

$$F(x) = N'[\phi_0(x) - \cdot 03671 \phi_4(x)].$$

The resulting ordinates are given and will be seen to be very far from the original figures. While of course we know we can reproduce the curve in Charlier's figure by using the negative frequencies we cannot help thinking that there are strong practical objections to the use of the curve in the form in which he writes it so long as such results as that just given can be obtained. If integration had been effected only over the positive area of the curve instead of from $-\infty$ to $+\infty$, the difficulty would not have arisen—but how is such integration to be effected?

The objections here raised to negative frequencies have been surmounted (as is, we think, theoretically necessary) in Edgeworth's work by leaving the equation in the form already given from which it can be seen that negative frequencies are impossible. There are however other difficulties that may arise and one of them can be seen in the example given by Edgeworth on pp. 522 and 523 of (2). This example deals with statistics of fecundity and the total frequency in the series of observations is 1000 while the totals in the first, second and third approximations in Table III, p. 523, are 947, 977 and 960 respectively. These differences between the calculated and observed frequencies are due to the area of part of the curve being neglected in reading off the graduation figures; in other words the frequency curve (Third Approximation) gives 40 cases out of 1000 as having *less than no members* in a family and the effect of this is that the frequency is on the average understated for the remainder of the curve. The application of Charlier's Type A would have given the graduation shown in the following table and a comparison of this graduation and Edgeworth's brings out the difference between the two methods to which reference has already been made.

For families of from 2 to 9 members, Edgeworth's graduation is close but both tails in his graduation and the start in Charlier's are quite unsatisfactory, while Charlier's curve gives a distorted graduation prior to 7 members, from which point however it agrees admirably. It seems probable however that Charlier would use his Type B for such a distribution and we have added a graduation by the third of his methods of fitting; the agreement is poor in comparison with that shown by Pearson's Type I. An attempt with Charlier's first method of fitting led to an unsatisfactory result. In all the graduations we could doubtless improve the agreement by using a greater number of terms in the series, but we think a considerable increase in the number would be required to give what we should consider a satisfactory graduation.

Size of family	Observations	Edgeworth's third Approximation	Charlier Type A† $\sigma=2{\cdot}928$; $\beta_3=-{\cdot}1214$ $\beta_4={\cdot}0104$	Charlier Type B	Pearson Type I‡
−3	—	1*	−2	—	—
−2	—	9*	4	—	—
−1	—	30*	15	12	2
—	64	64	38	64	67
1	116	102	71	104	116
2	140	130	108	129	138
3	145	135	137	134	139
4	134	130	148	128	128
5	106	111	135	116	110
6	82	92	108	93	89
7	72	73	78	73	69
8	49	53	54	53	51
9	37	36	37	36	35
10	25	20	27	25	24
11	13	10	18	14	15
12	10	4	12	10	9
13	5	—	7	5	5
14	2	—	4	2	2
15	·4	—	2	1	1
Totals	1000	1000	1001	1000	1000

* Approximation by help of diagram in Edgeworth (2).

† Notation of Charlier (6), mid-ordinates, found by Charlier's tables, being used.

‡ "Chances of Death," Vol. I. p. 74.

To the actuary, influenced perhaps by professional bias, the justification of a formula for graduating frequency distributions is its width of application ; to some extent we feel that such is also the justification of any theoretical conditions from which a curve is evolved. Edgeworth's series and Charlier's Type A will be found to give good graduations provided the distributions are not markedly skew but they become less satisfactory as the range of the observations takes a definite limit. Charlier's Type B on the other hand is certainly capable of graduating some distributions having a range limited in one direction but, though it can hardly be criticised fully at present, as the author states in (6) that his work on it is not yet complete, it may be well to point out that the solutions he gives are approximate and the choice of solution in any particular case seems somewhat arbitrary. The comparatively poor agreement reached above may be due to this approximate fitting and not to the failure of the curve itself. A statistical criterion to show whether Type A or Type B should be used in any particular case is certainly needed before these types can be used extensively in practice, but even then it would seem impossible to graduate the U-shaped distributions or those that rise abruptly from the axis of x at both ends.

One or two examples, besides that already mentioned, are given in (2), while there is a plentiful supply of statistical examples in (6) and most of them show a close agreement between the theoretical and actual frequencies ; some are less satisfactory and fig. 9 of (6) gives so poor a fit that the odds against the graduation are more than 50 to one. There are many other points of interest in (6) beside the main subject, such as a proof, on the basis of Type A, of the relative positions of the mode, mean and median, a method of checking the numerical calculation of moments, tables of the areas, ordinates and third and fourth differential coefficients of the normal curve, a table of $\psi(x)$ for Type B and a discussion of the dissection of a frequency distribution into components in which some approximate results are given and the suggestion of shortening the solution of the fundamental nonic by means of graphical work is made.

We have put forward the above criticisms to show the practical difficulties we have met in using the suggested methods; though these difficulties seem very important to us they do not blind us to the energy and ingenuity expended on the papers.

WILHELM FLIESS. *Der Ablauf des Lebens. Grundlegung zur exakten Biologie.* Leipzig, 1906, pp. 584 + viii.

As this is hardly the type of statistical work that will appeal to our readers it is unnecessary to criticise it.

W. P. E.

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VOLUME V FEBRUARY, 1907 No. 3

A BIOMETRICAL STUDY OF CONJUGATION IN PARAMECIUM.

BY RAYMOND PEARL, Ph.D., University of Pennsylvania, Philadelphia, Pa. U.S.A.

> "**** Isolation takes rank with Heredity and Variability as one of the most fundamental principles of organic evolution. For, if these other two principles be granted, the whole theory of descent resolves itself into an inquiry touching the causes, forms and degrees of Homogamy."
>
> ROMANES, 1897.

I. *Introduction.*

SOME time ago it occurred to the writer that it would be of considerable interest to determine whether there was any tendency towards "assortative mating" in the conjugation of Protozoa, especially in the case of the Infusoria. The nuclear phenomena of the process of conjugation in the Infusoria are now fairly well known, as a result of the fundamental researches in this field of Bütschli and Balbiani, and in more recent times of those of Richard Hertwig, Maupas, and Calkins. Briefly the essential facts regarding the process of conjugation are as follows: at intervals in the cultural history (and in nature) pairs of individuals firmly unite with one another and remain together for a certain, usually relatively short, period of time. During this time an exchange of nuclear material takes place. The nuclear and cytoplasmic changes preceding, accompanying and following this exchange are very characteristic, and suggest a certain parallelism to the phenomena connected with the maturation and fertilization of the ovum in sexually reproducing forms. After this exchange of nuclear material has occurred the individuals of the conjugating pair separate and begin anew a cycle of reproduction by fission. Without going at all into the much disputed questions of the homologies of the protozoan nucleus or the different phases of the conjugation process, it is clear that conjugation presents some interesting analogies, at least, to sexual processes in higher forms.

The point which I particularly wished to investigate was whether the original pairing in the conjugation process is entirely at random, or whether there is a tendency for individuals like one another in certain characters to pair together. Pearson and his associates have demonstrated that there exists in man a significant and measurable degree of assortative mating. This assortative mating is of two kinds, (*a*) preferential mating, and (*b*) homogamy. In homogamy there is a tendency for a class of males having a given character to unite with a class of females of a generally like character. This results in a positive correlation between the members of mated pairs with reference to the character under consideration. From his family measurement data Pearson* has found the following values for the coefficients of correlation measuring homogamy in man. These values measure the degree of correlation between husband and wife with respect to the characters enumerated.

Stature	·2804	1000 pairs.
Span	·1989	
Left fore arm	·1977	
Mean	·2257	

With reference to the character "duration of life" cooperative work† has shown that the mean correlation between husband and wife is ·2233. In general, the intensity of homogamy in man, so far as it has been investigated, may be considered to be fairly represented by a coefficient of correlation of from ·22 to ·23. This tendency of like to mate with like may be due either to "real conscious or unconscious assortative mating in man" or to individuals mating within local sub-races where, on account of the similarity of the environmental effects upon all individuals, there is little differentiation. If it be due to this latter cause, random mating would, of course, give a coefficient of correlation of approximately the same magnitude as that actually observed. That there is real assortative mating with reference to the character "duration of life" was demonstrated by observing that when male and female records were paired together at random the resulting coefficient of correlation differed from zero by less than half its probable error. Since, then, the observed positive correlation between husband and wife is not a mere chance result, the assortative mating thus demonstrated must be due either to conscious choice or to some unknown non-conscious factor.

Now it is quite clear that in the pairing of two infusorians in conjugation conscious choice is not likely to play any important part. Do we find assortative mating in such a case?

At the beginning of the fall semester of the academic year 1903—1904 Miss Mary J. Burr, a student in the University of Michigan, started work on this problem under my direction. As material she used the series of mounted slides of conjugating Paramecia which have for some years been used for teaching purposes in the Zoological Laboratory of that institution. These slides were prepared in 1895—1896 by the Honourable D. C. Worcester, Commissioner of the Interior of the Philippine Islands, who at that time was a member of the zoological staff of the University of Michigan, for the special purpose of serving as material for a study of the nuclear phenomena of conjugation. In this preliminary work 200 pairs of conjugants were measured by Miss Burr. These records form the series designated as *AA* in the present paper. A preliminary paper‡ was published on this work, but it was thought best not to publish the complete report until it could be checked with additional material.

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* *Biometrika*, Vol. I. p. 373.

† *Biometrika*, Vol. II. pp. 481—498.

‡ *Sixth Annual Report, Michigan Academy of Science*, pp. 184, 185.

After repeated failures I finally succeeded during the past summer (1905) in getting sufficiently abundant material of conjugating Paramecia in the Zoologisches Institut at Leipzig. This additional material made it possible to extend considerably the scope of the work beyond what had been planned when the investigation was begun. As will appear later the Leipzig material fully confirmed the results gained from the earlier *AA* series.

The main problems with which the present paper specifically deals may be stated as follows:

1. Is the portion of the Paramecium population which is in a state of conjugation at a given time differentiated in respect of type or variability or both, from the non-conjugating portion of the population living in the same culture at the same time?

2. Is there any tendency for like to pair with like ("assortative mating") in the conjugation of Paramecium, and if so, how strong is this tendency?

At this point I wish to acknowledge gratefully my indebtedness to those who have in various ways aided me in this work. To the officials of the Carnegie Institution I am indebted for a grant in aid of this and other biometric work now in progress. It is a pleasure to express my heartiest thanks for this aid. To Professors Carl Chun, and Otto Zur Strassen I am indebted for the numerous facilities of the Zoologisches Institut at Leipzig, which were so freely and kindly placed at my disposal during my stay there. The work was brought to completion in the Biometric Laboratory of University College, London, and it is a pleasure to acknowledge my great debt to Professor Karl Pearson for helpful advice and kindly criticism.

II. *Material and Methods.*

The material on which this paper is based is comprised in eight* series of measurements including altogether 1894 individual Paramecia. The cultural history of the different series is as follows:

Series AA, F_E *and* F_L. The individuals in these series were contained in the mounted slides in the Zoological Laboratory of the University of Michigan prepared by Professor D. C. Worcester as mentioned above. In series *AA* pairs of conjugants were chosen for measurement quite at random. In the *F* series the pairs were chosen on the basis of the nuclear condition for a special purpose, and in a manner which will be fully described later in the paper. Regarding the cultural history of this material information on some particulars is unfortunately lacking. The reason for this is that shortly after the material was collected by Professor Worcester he left the University on an exploring expedition to the Philippine Islands, and, having been afterwards called to public service there, the work on Paramecium was never completed. His notes made at the time the material was collected were misplaced and cannot now be found. The most essential points regarding the material he was, however, able to furnish me from memory. For his kindness in this matter I am very grateful. His statement is as follows:

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* *Note added Nov.* 10. In his before-publication criticism of this paper Mr J. J. Lister (*Nature*, Vol. 74, p. 584) suggests that I have mixed and lumped together these different series and that in consequence all my results are invalid. The reader of my paper will be able to judge of the correctness of Mr Lister's suggestion. I shall be very glad to have a specific instance where I have combined two or more series pointed out. I have always supposed it to be a fundamental axiom regarding the worth of scientific evidence, that the greater the number of pieces of *independent* evidence there are leading to the same conclusion by so much the more certain does that conclusion become. Acting on this principle I spent a great deal of time getting data from as many independent conditions as possible, and when, as appears in the paper, they all led to the same result, I began to feel that that result was the correct one. According to Mr Lister's new epistemological doctrine this conclusion was wrong and it would have been far better to have measured only one series of individuals. As a working biologist I cannot but feel that Mr Lister ought in justice to his colleagues to issue a definite statement as to whether in his own investigations he follows the principle that the evidence of one witness is more trustworthy than that of several independent witnesses. R. P.

The material "was obtained originally by collecting decayed cow-lily leaves from one of the Three Sister Lakes*. The material collected was put into stender dishes in the laboratory and covered in the usual way.......A little later an epidemic of conjugation started in one of the dishes. It had not progressed far when I discovered it, and from that time for three or four days killings were made at regular intervals, as is usually done with developing embryological material. I cannot state at this time just what the intervals were, but if the bottles in which the material was preserved still exist they ought to show†. The killings were kept up as long as there seemed to be any use in continuing them in order to get a complete series of specimens. The killing fluid was four per cent. solution of formaldehyde saturated with bichloride of mercury. The method pursued was to nearly fill a four-dram homœopathic vial with the killing fluid and then squirt violently into it a considerable amount of water containing as many Paramecia as possible. As soon as the Paramecia had settled to the bottom of the vial the killing fluid was drawn off and the specimens were shaken up two or three times in distilled water, which was drawn off in each instance as soon as settling had taken place. They were then stained for twelve hours in a one per cent. solution of picrocarmine, rinsed in distilled water, carefully dehydrated‡, and left in cedar oil, where they seemed to retain their colour perfectly. Mountings were ultimately made in xylol damar, covering glasses being supported by capillary glass rods to prevent crushing of the specimens. I have neglected to state that when the epidemic of conjugation began in this dish I drew off all available material and placed it in clear water in a smaller dish, for convenience in killing. In making the above statements I am, of necessity, trusting entirely to memory, but am very confident that they are correct."

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* Small glacial lakes in the vicinity of Ann Arbor. R. P.

† This they unfortunately do not. R. P.

‡ By a highly ingenious process which made the change to the higher grades of alcohol perfectly gradual and so avoided distortion from diffusion currents. To the apparatus which he devised for this purpose Professor Worcester's success in producing such perfect preparations as these are, was, I believe, largely due. R. P.

From the above account it will be seen that the conjugation was between individuals from the same culture. Regarding the general character of this material, I can only say that the preparations are by far the finest I have ever seen of fixed and mounted infusoria, in point of giving a true representation of the condition of the living organisms in respect of shape and size of body. This I may say has been the comment of all who have seen the slides. Unfortunately the stain has now faded somewhat, so that the nuclear conditions are not shown as clearly as was formerly the case.

Series A, C, D and E. The individuals included in these series all came from a single culture in the Zoologisches Institut at Leipzig. This culture was set with dry hay and pond water in an aquarium jar holding about three litres, July 25th, 1905. In about a week there was an abundance of infusorian forms in the culture, the dominant species in point of numbers being *Chilomonas paramecium, Paramecium caudatum,* and an unidentified species of the common hypotrichan genus *Oxytricha,* together with immense numbers of a large form of the bacterium *Spirillum.* Very soon the *Oxytrichae* began to diminish in numbers, while at the same time the Paramecia rapidly increased until finally there was a very flourishing culture of this form. At this time I was measuring for another purpose specimens of *Chilomonas* from this culture, and on Tuesday, August 15th, I noticed on a slide which had been mounted during the afternoon of the Saturday before a single pair of conjugating Paramecia. A careful search through samples taken from the culture was at once instituted, with the result that during the remainder of that day I succeeded in finding eight pairs of conjugants. The next day in seven hours of continuous searching I found 22 pairs, the next day 54 pairs, and from that time on the numbers continued to increase until the height of the epidemic was passed. From these facts it will be evident that the epidemic was only just at its beginning on August 15th. It should be stated that from the time all of the cultures were started regular routine examinations were made to see whether conjugation was occurring in any of them. No conjugating individuals were found before this first pair on August 15th.

The plan which it seemed wisest to follow in handling this material was to take samples at somewhat widely separated intervals during the course of the conjugation epidemic. It was deemed best to follow this plan because I had strong reasons to expect, from an experimental study* on variation in Paramecium which has been going on for some two years, that there would be a marked cyclic change in the variation constants during the course of the epidemic, due to environmental influences. It seemed desirable to detect and measure such a progressive change if it should occur. Now it is evident that the simplest way to attain this end would be to make bulk killings of large samples of the culture at suitable intervals, and then measure the preserved individuals at leisure. This method, however, I did not dare to adopt for the reason that the conjugants

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[*] For a preliminary report see Pearl, R., and Dunbar, F. J., "Some Results of a Statistical Study of Variation in Paramecium." *Seventh Report, Michigan Academy of Science,* pp. 77—86.

were, throughout the epidemic, present in relatively small numbers. It was feared that if large enough samples were taken to ensure statistically adequate numbers of conjugating pairs the culture would either be exhausted, or its balance so disturbed that the Paramecia would rapidly disappear from it. Accordingly the plan adopted was to take a single drop of culture fluid on the slide at a time, search carefully through it, and if a pair of conjugants were found, kill and measure them in the manner presently to be described. By working in this way as rapidly as was consistent with accuracy, it was possible to measure a reasonable sample in two or three working days.

Between each of the different samplings made in this way roughly a week elapsed. It would, of course, have been possible to have measured, even on this plan, somewhat larger samples than those actually taken, but it was hardly practical. After searching and measuring under high pressure for three days of about eight working hours each, one's eyes were so fatigued by the strain that further work without an intervening period of rest was almost an impossibility. The samples taken are, moreover, quite adequate, I think, to show the prevailing condition in the culture at the time.

The measurements taken, then, fall into time groups, as shown in the following table.

Series	Dates of Measurement	Number of Conjugants measured	Number of Non-Conjugants measured
A	August 15th P.M.—August 18th noon, inclusive	105 pairs	210
C	„ 24th A.M.— „ 26th P.M. „	101 „	202
D	„ 30th	16 „	32
E	September 6th		132

A word of explanation is needed regarding Series *D* and *E*. These series would have been as large as the others but for the fact that there were but few individuals in the culture to be measured. By August 30th the epidemic of conjugation was practically over. The 16 pairs of Series *D* were all that could be found after a painstaking search lasting all day, and with two persons working separately. I was compelled then to do with this very short series. No reason for the ending of the epidemic was evident, so far as the observable cultural conditions were concerned.

By September 6th, however, the case was somewhat different. During the week from August 30th to September 6th blue-green algae had begun to grow very rapidly in the culture, until at the latter date they had formed a more or less dense mat over nearly the whole surface of the culture. Concurrently with this increase in the algae the numbers of Paramecia had steadily and rapidly diminished, so that there were comparatively few survivors, and it was only with some difficulty that I got the 132 which were measured. These survivors were obviously different from what had been the prevailing type of non-conjugants in Series *C* and *D*, the most noticeable fact being that the individuals in Series *E* were unusually broad in proportion to their length. All conjugants, of course, had disappeared long before Series *E* was taken. After September 6th the growth of algae rapidly increased, and by September 8th Paramecia had completely disappeared from the culture so far as I could determine.

We have then, from this single culture, 1020 individuals included in four samples taken at intervals covering practically the whole course of a conjugation epidemic.

Series B. This is a very short series, comprising only 12 pairs of conjugants and 24 non-conjugants. These came from another of my cultures at Leipzig, set like the one described above, with hay and pond-water and at the same date, July 25th. It, however, had developed in a somewhat different direction, probably largely as a result of having been placed in slightly different conditions with respect to light. The dominant organisms in this culture were algae, various species of *Euglena*, hypotrichous infusoria, both large and small, and *Paramecium*. Conjugating Paramecia were first found in this culture on the morning of August 22nd, and measurements on them were begun at once, on the same plan as that adopted in Series *A*, *C*, *D*, and *E*. During that day only 10 pairs of conjugants were found. From this it was concluded that an epidemic of conjugation was just starting; but this was not the fact, for on the next day, with the most thorough searching, only two pairs of conjugants were found. After that none were found. It seems likely that in this instance there was no true conjugation epidemic at all, but that instead the fact was that in a restricted portion of the culture a limited number of individuals reached the physiological condition for conjugation at the same time.

We may now discuss the methods used in killing and measuring the material, and in the calculation of the constants. The method used in killing and mounting the individuals of Series *AA* and *F* has already been described (p. 216). The measuring on these series was done with an ordinary ocular micrometer at a relatively low magnification, such that in Series *AA* one division of the micrometer was equal to 13 microns, and in the *F* series to 8·6 microns. At the time these measurements were made no filar micrometer ocular was available. The units of measurement were really a half of 13 microns and 8·6 microns respectively, because at the low magnification it was possible to estimate accurately with the eye whether the points to be measured fell within the upper or lower half of a scale division. It was neither practicable nor, considering the objects in view, worth while to make any closer measurements on these series.

The other series discussed in this paper, viz., *A*, *B*, *C*, *D* and *E*, were killed and measured in a somewhat different way. First as to the killing; whenever, in examining a drop of culture fluid on a slide a pair of conjugants was seen, all the individuals on that slide were killed by dropping on it from a pipette eight to ten times as much killing fluid as there was water. The killing fluid used was

Worcester's formol-sublimate mixture*, consisting of a saturated solution of corrosive sublimate in 10 per cent. formalin. This fluid, when properly used, kills Paramecium without visible distortion or shrinkage†. It is the fluid which has been used in collecting the extensive series of Paramecium material mentioned above (p. 216). Some time has been spent in an attempt to measure the same individuals before and after killing, but it has not been possible to find a means which would keep them quiet enough to measure during life with anything approaching accuracy, which did not obviously distort them at the same time. This statement is made after considerable experience with the various substances which have been suggested for this purpose, such as, for example, thin gelatine solutions, etc. That whatever of shrinkage and distortion is produced by the use of the killing fluid is less than the errors of measuring I am certain, though at present I cannot give figures to prove this. Of course it is not to be understood that absolutely all the individuals so killed will not be distorted. Naturally, there will always be specimens which the killing fluid reaches only in a diluted state, but such specimens will be obviously recognizable as distorted, and of course will not be included in the records.

The individuals were at once measured while still in the killing fluid. By this procedure any distortion which might arise from the action of diffusion currents was avoided. The search for conjugant pairs was greatly facilitated by the use of a mechanical stage. The microscope used was by Bausch and Lomb, and the actual magnification was that given by a $\frac{2}{3}$ inch objective and a 1 inch ocular, with a tube length of 160 millimetres. The method of measuring followed was the same as had been previously used in a study of variation in *Arcella*‡. By means of a camera lucida the points to be measured were projected on cards, marked with a fine-pointed pencil, and subsequently measured with a sliding-arm caliper with a vernier reading to tenths of a millimetre. By multiplying the measurements in millimetres so obtained by the proper reduction factor found by calibrating with a stage micrometer divided to hundredths of a millimetre, they were reduced to microns, and so recorded. The arrangement of microscope, camera and paper, was of course kept the same throughout the measuring.

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* Cf. Pearl, R., *Journal of Applied Microscopy*, Vol. VI. p. 2451.

† *Note added Nov.* 10. In his criticism of this paper, Mr Lister (*loc. cit.*) says : "In the first place, the specimens have been preserved and fixed, a process which every practical biologist knows to be attended with distortion." By this statement Mr Lister can only intend to spread abroad as widely as possible an *ex cathedra* pronouncement that I am not a "practical biologist." During the last six years a large part of my time has been spent in the study of living and fixed Paramecia. From statements made in Mr Lister's note I am convinced that he has *never* made any *careful* or *thorough* study of Paramecium (cf. *infra*, p. 221). Yet, so far as I can see, for no other reason than that I happen to be in a very modest way a worker in biometry, Mr Lister says that I am not a "practical biologist," and with all the weight of his authority implies that my statement that my material was undistorted is not true.

I know of no way to answer a criticism which simply denies the existence of a scientific conscience. Fortunately the innate courtesy of men of science generally makes such criticisms rare. I can only repeat what is stated in the paper above that the distortion produced by the method of killing I have used on Paramecium is well within the limits of instrumental error in the measuring, or in other words that the specimens were not visibly distorted. The truth of this statement I stand ready to demonstrate directly to anyone interested, by exhibition of living and killed specimens side by side. In the present state of development of micro-photographic technique it is unfortunately not a thing which can be demonstrated on paper. R. P.

‡ Pearl, R., and Dunbar, F. J.: *Biometrika*, Vol. II. pp. 321—357.

With reference to the selection of individuals to measure, it may be said that in Series A, B, C, D and E specimens were taken entirely at random. Every pair of conjugants, not obviously distorted, which were found on a slide were measured. When the dimensions of the conjugant pair had been marked off, the *two undistorted non-conjugants which were nearest to the conjugant pair* in the field of view were measured. By taking the non-conjugants in this way any sub-conscious tendency to choose with reference to size characters was avoided. No selection of conjugant pairs on the basis of size was exercised, or was even possible, because all conjugant pairs seen were measured with the exception of a very few—less than 15 pairs out of all measured—which were obviously distorted. In Series AA no non-conjugants were measured. The conjugant pairs were taken as in the other series, i.e., all undistorted conjugants on a slide were measured. In Series F the conjugants were chosen with reference to nuclear condition and separated into two groups on this basis. One group—"Series F, Early"—consisted of specimens in very early stages of the conjugation process and included only individuals in which the micronucleus had not yet divided, and either had not moved out of its notch in the macronucleus, or if it had, was still lying near and *anterior to it.* The other group—"Series F, Late"—included only pairs in which separation was soon to ensue, where namely the exchange of nuclear material was in process or had already taken place. For two reasons it was very difficult to get even as many specimens as were obtained in these two sharply separated stages. In the first place, in the very early and very late stages of the conjugation process the nuclear changes go on rather rapidly, and as they are perfectly continuous it is obvious that of any single restricted stage there will not be a large number of representatives. Furthermore, some were rejected which should undoubtedly have been included, but in which, on account of the stain having faded, it was impossible to be certain of the stage. No non-conjugants were measured in Series F.

The characters measured were the length and greatest breadth of the body, in all the series except F, where only the length was measured. In taking these measurements the length offered no difficulty, nor did the breadth in the case of the non-conjugants*. In the case of the conjugants, however, the breadth is a difficult character to measure, principally for the reason that the line of union between the two individuals is in many cases somewhat indistinct, and it thus becomes difficult to decide at just what point the body of one individual ends and that of the other begins. Furthermore, the close application of the oral surfaces of the bodies of the conjugants to each other in all but the earliest stages of the conjugation process changes somewhat the shape of a cross section of the body. This change is in the direction of a flattening of the oral (ventral) side of the body. Since for obvious reasons in the case of the conjugants the longest dorso-ventral diameter in the sagittal plane had to be taken as the breadth dimension, it is clear that any tendency towards flattening of the oral contour will appear directly in the measurements. The result of such a tendency will be to make the mean breadth lower, relatively to the length, in the conjugants as compared with the non-conjugants. As will be seen later, this is exactly what the measurements show. The conjugants are, in proportion to their length, narrower than the non-conjugants. For the reasons just stated, no special weight must in the opinion of the writer be laid on the breadth dimensions of the conjugants. The difficulties in the case were perfectly apparent while the measurements were being made, and the breadth dimensions for the conjugants were only included as a matter of routine, and because there was some curiosity to see how the constants would turn out. As a matter of fact the results are much better, i.e., more regular and consistent from series to series, than was expected after the appreciation of the difficulties in the case which one gets from seeing and measuring the actual specimens. It should be kept distinctly in mind, however, that much weight cannot be laid on the results from the *breadth* measurements of *conjugants.*

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* *Note added Nov.* 10. Mr Lister (*loc. cit.*) says: "Paramecium, as is well known, is not a symmetrical animal. It has been described as 'slipper-shaped'—not a very good comparison, but it will serve to bring out the fact that the proportion of length and breadth presented to the observer will vary according to the aspect from which the individual is viewed." With all due respect to Mr Lister's authority I wish to point out the fact that this statement is *entirely erroneous* so far as the maximum breadth dimension of a normal Paramecium is concerned. The maximum breadth falls at a transverse plane of the body posterior to the oral groove. At the level of the maximum breadth the outline of a cross-section of the body of Paramecium is circular, and the maximum breadth

In both the conjugant and non-conjugant individuals the point on the long axis of the body where the line of greatest breadth crossed it had, of necessity, to be estimated by the eye, but, owing to the shape of the body, this usually gives no difficulty in practice. In a normal Paramecium the outline of the body slopes off rather sharply from the region of the greatest breadth to the posterior end. The region of greatest breadth varies somewhat in relative position in different individuals and in different samples. It usually falls slightly behind the

dimension is in consequence the same whatever side of the animal happens to be uppermost. This I take to be a fact known to everyone who has more than the most superficial objective acquaintance with Paramecium. There are very many ways in which it can be demonstrated. One very simple way is to bring a living Paramecium which is rotating on its long axis into such position that its maximum breadth dimension falls between two cross hairs of an ocular micrometer. Another way is to observe with a Braus-Drüner microscope a living Paramecium standing on end, so that one gets a direct view of the posterior end. It will then be seen that the outline at the plane of greatest breadth is a circle. Finally if Mr Lister will look at an actual cross-section (1 to 5 microns thick) of the body of a Paramecium he will see that in the region of the greatest breadth the sections are circular in outline. With his notions of the limitations of technique Mr Lister may doubt the possibility of making these sections, but I have studied a long series of such sections of Paramecium. It seems a very trivial thing to say in a technical paper, but apparently it needs to be pointed out to Mr Lister at least that the asymmetry of Paramecium is the result of the asymmetrical course of the oral groove. Posterior to the oral groove the animal is entirely symmetrical. R. P.

mouth, but may be at the level of the mouth. In cases of doubt as to where the greatest breadth was, a series of transverse diameters were marked off and the longest diameter by actual measurement on the card taken as the breadth. It was necessary to do this in but few cases, however.

To prevent any possibility of misunderstanding as to the measurements taken, the outline drawings in Fig. 1 are introduced.

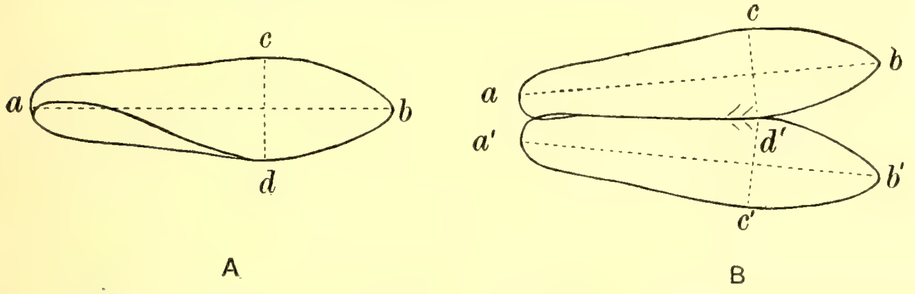

FIG. 1. Diagram to show measurements taken. *A*, Non-conjugant. *B*, Pair of conjugants. *ab* and *a'b'* = lengths. *cd* and *c'd'* = breadths.

Besides the characters length (L) and breadth (B), the length-breadth index $= 100\,B/L$, and the *difference* (in microns) between the lengths of the two individuals of the conjugant pair ($= L_{A \text{ or } B} - L_{B \text{ or } A}$) or of the two individuals of a random pair of conjugants or non-conjugants were studied. The "difference" was taken as always positive, or in other words, without reference to whether A or B was the shorter member of the pair.

The species of Paramecium was the same in all the series, namely *P. caudatum.* I was in some doubt at the outstart as to whether the Leipzig form might not be *P. aurelia,* but a careful examination of stained specimens left no doubt that this form had but one micronucleus, thus agreeing in this, as in all the other specific characters, with the form studied at Ann Arbor, namely, *P. caudatum.*

Finally, as to the calculation of the biometric constants tabulated, it may be said that the ordinary methods, now well known, were followed. In all cases, unless a specific statement to the contrary is made, it will be understood that Sheppard's correction of the second moment was used in getting the standard deviation. In determining the constants for the short series B and D, the material was not grouped at all. For the units of grouping in the other series the reader is referred to the tables in the Appendix to this paper. The constants are tabled to three places of decimals in the case of the means, standard deviations and coefficients of variation, and four places in the case of the coefficients of correlation. It will be understood that in the computing decimals were kept to a larger number of places.

There is one point which needs mentioning regarding the method of recording the data in the case of the conjugants. In every instance the *first individual* *of a pair of conjugants to be measured* was recorded as A, and the second measured as B. Since the order of measurement was entirely random, it is clear that with reference to size, both A and B groups are random samples out of the whole conjugant population $A+B$. Their constants then should be sensibly equal.

III. *Fundamental Constants.*

For the sake of convenience in reference, the constants for variation in the various series are collected and shown together in Table I. In the first column of the table is given the letter designating the series; in the second column the class, i.e. conjugant or non-conjugant; in the third column the character, i.e. length, breadth, index or difference; in the fourth column the number of the correlation table in the Appendix, from which the values of the constants on the same horizontal line were deduced; in the fifth, sixth and seventh columns respectively the means, standard deviations and coefficients of variation, and their probable errors; and finally, in the eighth column, the number of individuals included in the frequency distributions from which the constants were calculated. The means and standard deviations for length, breadth and difference are given in microns; for the index in per cent.

IV. *Variation in Paramecium.*

Before considering especially the specific problems of the paper it will be of interest to compare our results as to variability in this form with those obtained from other series. To this end Tables II. and III. have been formed. Table II. gives the means, standard deviations, and coefficients of variation for the character length in the total series of the present paper in bold faced type, together with the same values for (a) Simpson's* series of 100 individuals; (b) a series of 250 individuals taken from a culture at Ann Arbor†; (c) three "control" series of 500 individuals each, all descended from a common ancestor, and kept in a small volume of culture fluid for 100, 200 and 300 hours respectively‡; (d) three series of 500 individuals each, all descendants from the same ancestor as gave rise to the control series enumerated under (c), but reared for 100, 200 and 300 hours respectively in a very weak solution of cane sugar‡.

This table brings out a number of points of interest. In view of the rather large total number of individuals we may safely conclude I think that it gives a fairly trustworthy representation of the degree of variability of Paramecium in respect to the character length of body. It is obvious that generally with an increase in the mean there is associated an increase in the standard deviation

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* *Biometrika*, Vol. I. p. 405.

† Pearl, R., and Dunbar, F. J.: *Seventh Report, Michigan Academy of Science*, pp. 77—86, 1905.

‡ *Ibid.* An account of the experiments on which these series are based will be found in the paper referred to.

TABLE I.

Constants of Variation in Paramecium.

Series	Class	Character	Table	Mean	Standard Deviation	Coefficient of Variation	No.
A	Conjugant *A* ...	Length	*A* 3	167·976 ± ·695	10·559 ± ·491	6·286 ± ·294	105
”	” *A* ...	Breadth	*A* 5	43·358 ± ·253	3·840 ± ·179	8·856 ± ·415	105
”	” *A* ...	Index	*A* 7	25·814 ± ·173	2·626 ± ·122		105
”	” *B* ...	Length	*A* 3	168·310 ± ·779	11·827 ± ·550	7·027 ± ·329	105
”	” *B* ...	Breadth	*A* 5	45·386 ± ·279	4·240 ± ·197	9·343 ± ·439	105
”	” *B* ...	Index	*A* 7	26·862 ± ·175	2·665 ± ·124		105
”	All Conjugants ...	Length	*A* 1	168·143 ± ·522	11·212 ± ·369	6·668 ± ·220	210
”	” ” ...	Breadth	*A* 1	44·371 ± ·194	4·170 ± ·137	9·398 ± ·312	210
”	” ” ...	Index	*A* 8	26·338 ± ·126	2·697 ± ·089		210
”	” ” ...	Difference	18	8·943 ± ·435	6·610 ± ·308	73·914 ± 4·978	105
”	„ Non-Conjugants	Length	*A* 2	189·976 ± ·724	15·549 ± ·512	8·185 ± ·271	210
”	” ”	Breadth	*A* 2	52·827 ± ·273	5·870 ± ·193	11·112 ± ·370	210
”	” ”	Index		27·848 ± ·116	2·502 ± ·082		210
”	” ”	Difference	18	17·619 ± ·785	11·924 ± ·555	67·676 ± 4·359	105
C	Conjugant *A* ...	Length	*C* 3	176·064 ± ·887	13·222 ± ·627	7·510 ± ·358	101
”	” *A* ...	Breadth	*C* 5	42·906 ± ·226	3·372 ± ·160	7·860 ± ·375	101
”	” *A* ...	Index	*C* 7	24·342 ± ·161	2·399 ± ·114		101
”	” *B* ...	Length	*C* 3	175·965 ± ·870	12·965 ± ·615	7·368 ± ·351	101
”	” *B* ...	Breadth	*C* 5	43·411 ± ·231	3·436 ± ·163	7·915 ± ·378	101
”	” *B* ...	Index	*C* 7	24·649 ± ·159	2·372 ± ·113		101
”	All Conjugants ...	Length	*C* 1	176·015 ± ·621	13·094 ± ·439	7·439 ± ·251	202
”	” ” ...	Breadth	*C* 1	43·158 ± ·162	3·414 ± ·115	7·910 ± ·267	202
”	” ” ...	Index		24·495 ± ·113	2·390 ± ·080		202
”	” ” ...	Difference	18	7·931 ± ·448	6·681 ± ·317	84·245 ± 6·219	101
”	„ Non-Conjugants	Length	*C* 2	209·356 ± ·906	19·099 ± ·641	9·123 ± ·309	202
”	” ”	Breadth	*C* 2	54·208 ± ·280	5·905 ± ·198	10·894 ± ·370	202
”	” ”	Index		25·911 ± ·106	2·238 ± ·075		202
”	” ”	Difference	18	21·010 ± 1·003	14·939 ± ·709	71·105 ± 4·785	101
D	Conjugant *A* ...	Length	*D* 1	181·250 ± 2·288	13·571 ± 1·618	7·487 ± ·898	16
”	” *B* ...	”	*D* 1	182·563 ± 2·099	12·445 ± 1·484	6·817 ± ·817	16
”	All Conjugants ...	”	*D* 1	181·906 ± 1·554	13·037 ± 1·099	7·167 ± ·607	32
”	„ Non-Conjugants	”	*D* 1	217·656 ± 2·319	19·453 ± 1·640	8·937 ± ·759	32
E	All Non-Conjugants	Length	*E* 1	214·470 ± 1·074	18·291 ± ·759	8·529 ± ·357	132
”	” ”	Breadth	*E* 1	63·250 ± ·340	5·786 ± ·240	9·149 ± ·384	132
”	” ”	Index	*E* 2	29·508 ± ·125	2·132 ± ·089		132
B	Conjugant *A* ...	Length	*B* 1	169·667 ± 3·813	19·581 ± 2·696	11·541 ± 1·610	12
”	” *B* ...	”	*B* 1	166·667 ± 2·324	11·938 ± 1·644	7·163 ± ·991	12
”	All Conjugants ...	”	*B* 1	168·167 ± 2·242	16·285 ± 1·585	9·684 ± ·953	24
”	„ Non-Conjugants	”	*B* 1	199·708 ± 1·890	13·727 ± 1·336	6·874 ± ·672	24
AA	Conjugant *A* ...	Length	*AA* 1	218·150 ± 1·110	18·901 ± ·637	8·664 ± ·294	200
”	” *A* ...	Breadth	*AA* 1	56·880 ± ·476	8·114 ± ·274	14·265 ± ·491	200
”	” *B* ...	Length	*AA* 2	217·200 ± 1·134	19·309 ± ·651	8·890 ± ·302	200
”	” *B* ...	Breadth	*AA* 2	56·445 ± ·523	8·901 ± ·300	15·769 ± ·545	200
”	All Conjugants ...	Length	*AA* 3	217·675 ± ·645	19·112 ± ·456	8·783 ± ·211	400
”	” ”	Breadth	*AA* 4	56·663 ± ·287	8·519 ± ·203	15·035 ± ·367	400
F_E	Conjugant *A* ...	Length	*F* 1	209·103 ± 1·432	17·767 ± 1·013	8·497 ± ·488	70
”	” *B* ...	”	*F* 1	207·874 ± 1·345	16·689 ± ·951	8·028 ± ·461	70
”	All Conjugants ...	”	*F* 2	208·489 ± ·983	17·247 ± ·695	8·272 ± ·336	140
F_L	Conjugant *A* ...	Length	*F* 3	214·497 ± 1·378	17·927 ± ·974	8·357 ± ·458	77
”	” *B* ...	”	*F* 3	213·604 ± 1·353	17·609 ± ·957	8·244 ± ·451	77
”	All Conjugants ...	”	*F* 4	214·051 ± ·966	17·774 ± ·683	8·304 ± ·321	154

TABLE II.

Variation in the Length of Paramecium.

Series and Class	Mean	Standard Deviation	Coefficient of Variation	No.
Series *A*, All Conjugants	**168·143 ± ·522**	**11·212 ± ·369**	**6·668 ± ·220**	210
„ *C*, „ „	**176·015 ± ·621**	**13·094 ± ·439**	**7·439 ± ·251**	202
Selected Ancestry, 300 hour, control†	182·200 ± ·480	15·917 ± ·340	8·736 ± ·188	500
Series *A*, All Non-Conjugants ...	**189·976 ± ·724**	**15·549 ± ·512**	**8·185 ± ·271**	210
Selected Ancestry, 200 hour, control†	207·080 ± ·518	17·171 ± ·366	8·292 ± ·178	500
Series F_E, All Conjugants	**208·489 ± ·983**	**17·247 ± ·695**	**8·272 ± ·336**	140
Series *C*, All Non-Conjugants ...	**209·356 ± ·906**	**19·099 ± ·641**	**9·123 ± ·309**	202
Selected Ancestry, 300 hour, sugar†	213·340 ± ·601	19·936 ± ·425	9·345 ± ·201	500
Series F_L, All Conjugants	**214·051 ± ·966**	**17·774 ± ·683**	**8·304 ± ·321**	154
Series *E*, All Non-Conjugants ...	**214·470 ± 1·074**	**18·291 ± ·759**	**8·529 ± ·357**	132
Selected Ancestry, 200 hour, sugar†	217·380 ± ·592	19·630 ± ·419	9·030 ± ·194	500
Series *AA*, All Conjugants	**217·675 ± ·645**	**19·112 ± ·456**	**8·783 ± ·211**	400
Selected Ancestry, 100 hour, control†	221·800 ± ·587	19·457 ± ·415	8·772 ± ·189	500
„ „ 100 „ sugar†	224·980 ± ·533	17·680 ± ·377	7·859 ± ·169	500
Simpson's Series*	229·050 ±	19·152 ±	8·361 ±	100
Ann Arbor Series†	246·080 ± ·983	23·041 ± ·695	9·363 ± ·285	250
Total				5000

so that, as a result, the coefficients of variation, measuring the amount of variation relative to size, cluster well together in value. It may be concluded, I think, until equally extensive series showing a different result are forthcoming, that the usual or "normal" value for the coefficient measuring variation in the length of *Paramecium caudatum* is 8—9 °/$_{\circ}$. The good agreement in the values of the coefficients of variation for the different series is very satisfactory, and is something which probably no biologist would have predicted before measurements were made. One has been accustomed to think that Paramecium because it is a soft-bodied creature is likely to show great and altogether irregular fluctuations. As a matter of fact Paramecium *is distinctly less variable in size than is, for example, Arcella*‡ (coefficient of variation = 10·2676 °/$_{\circ}$) or the crab, *Eupagurus prideauxi*§ (coefficient of variation for carapace length = from 12 to 19 °/$_{\circ}$), or the ophiuroid, *Ophiocoma nigra*|| (coefficient of variation > 20 for both disc-breadth and arm-length), all which organisms have a more or less firm exo-skeleton. Furthermore it is perhaps of some interest to note that the degree of variation in length of Paramecium is of the same general order of magnitude as that in the capacity of the human skull.

There can be no doubt I think of the substantial homogeneity of each of the series. Especially does this impress itself when we compare the variability of

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* *Biometrika*, Vol. I. p. 405.

† Pearl, R., and Dunbar, F. J.: *Seventh Report, Michigan Academy of Science*, pp. 77—86, 1905.

‡ Pearl, R., and Dunbar, F. J.: *Biometrika*, Vol. II. p. 327.

§ Schuster, E. H. J.: *Biometrika*, Vol. II. p. 195, Table VIII. *bis*.

|| McIntosh, D. C.: *Biometrika*, Vol. II. pp. 463—473.

the various "Selected Ancestry" series with random series, whether conjugant or non-conjugant. The individuals in these "Selected Ancestry" series all came from the same original single ancestor, and each sample was reared throughout its history under as uniform environmental conditions as it was possible to obtain.

It is apparent that when the table is viewed as a whole the individuals in the conjugant series tend to be both smaller and less variable than those in the non-conjugant series. In the early history of the Leipzig culture all the individuals in it were small, but, as will be shown later in a more direct way, throughout the period during which it was under observation the mean size of the individuals increased. At the same time the variability in proportion to size tended to increase somewhat.

Turning now to the character breadth we unfortunately have at present only one other series for comparison with those reduced in this paper. For the present the longer non-conjugant series alone will be considered with reference to this character. The results are shown in Table III.

TABLE III.

Variation in Breadth of Paramecium.

Series and Class	Mean	Standard Deviation	Coefficient of Variation	No.
Series *A*, All Non-Conjugants ...	52·827 ± ·273	5·870 ± ·193	11·112 ± ·370	210
" *C*, " " ...	54·208 ± ·280	5·905 ± ·198	10·894 ± ·370	202
" *E*, " " ...	63·250 ± ·340	5·786 ± ·240	9·149 ± ·383	132
Simpson's Series	68·125	9·155	13·439	100

From this table it is at once evident that in proportion to the magnitude of the dimension the breadth is somewhat more variable than the length in Paramecium, but the difference is not great. The values of the means are, for all three of the present series, lower than that for Simpson's, but this is only what would be expected from the fact that the mean lengths are lower for these particular series also. It would appear that, as the breadth increases in magnitude, it becomes proportionally less variable, but the series of data available at present are too few to decide whether such a relationship is usual.

If we consider the variation analytically we have the results shown in Table IV. This table gives the values of mean, mode, μ_2, μ_3, μ_4, β_1, $\sqrt{\beta_1}$, β_2, $3-\beta_2$, κ_2, and the skewness* for the length and breadth of all conjugants and all non-conjugants of Series *A*. I have not thought it worth while to determine the analytical constants for any other of the present series for the reason that they are statistically so short, and because I hope to be able to publish eventually the reductions of much more extensive material on variation in Paramecium.

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* The analysis of these curves is carried out by the methods given in Pearson's memoir on Skew Variation (*Phil. Trans.* Vol. 186 A, pp. 343—414), and its Supplement (*Ibid.* Vol. 197 A, pp. 443—459).

In order to test the approach of the distributions to the normal law the probable errors have been determined for the four constants chiefly concerned in such a test, viz. $\sqrt{\beta_1}$, β_2, d (= difference between mean and mode) and the skewness, *on the assumption that the distributions follow the normal or Gaussian law.* These probable errors will then define the amount by which the constants will fluctuate, on account of the errors of random sampling from their true values for the normal curve. If the observed values of the constants differ from their theoretically true values by more than two or three times their probable errors, we shall conclude that the distribution does not follow the normal law in one or more particulars. The values for the probable errors of the four constants mentioned, on the assumption that the distributions are normal are as follows: Probable error of $\sqrt{\beta_1} = \pm \cdot 1140$ for each distribution; probable error of $\beta_2 = \pm \cdot 2280$ for each distribution; probable error of the skewness $= \pm \cdot 0570$ for each distribution; finally the probable errors of d are (a) for length of conjugants, ± ·6391, (b) for breadth of

TABLE IV.

Analytical Constants for Variation in Paramecium.

Constant	Series *A*			
	Conjugants		Non-Conjugants	
	Length	Breadth	Length	Breadth
Number of Individuals ...	210	210	210	210
Unit	5 microns	3 microns	5 microns	3 microns
μ_2	5·0287	1·9323	9·6714	3·8286
μ_3	– ·9882	1·1952	6·2239	1·9867
μ_4	72·6598	13·5622	270·7506	42·6096
β_1	·0077	·1980	·0428	·0703
$\sqrt{\beta_1}$	·0876	·4450	·2069	·2652
β_2	2·8733	3·6323	2·8946	2·9069
$3-\beta_2$	·1267	– ·6323	·1054	·0931
κ_2	– ·0209	·2330	– ·0958	– ·1353
Mean	168·1429*	44·3714*	189·9762*	52·8269*
Mode	168·6853*	43·5997*	188·1581*	51·9275*
d	·5424	·7717	1·8181	·8994
Skewness ...	– ·0484	·1851	·1169	·1532

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* It will be understood that the absolute values of mean and mode are given, and not, as in the case of the moment-coefficients, the values in terms of the unit at the head of each column.

conjugants, ± ·2377, (*c*) for length of non-conjugants, ± ·8863, and (*d*) for breadth of non-conjugants, ± ·3346.

It will at once be noted that the skewness is positive in three out of the four cases, or in other words, that the mean falls at a higher value than the mode in these distributions. Having regard to the probable errors, however, the skewness and difference can be regarded as certainly significant in only one distribution —that for the breadth of conjugants. For the length of the conjugants both these constants have values sensibly equal to zero. For both of the non-conjugant distributions it is somewhat doubtful whether the skewness and difference are to be considered to have significant values, but probably they are. It should be said, however, that so far as symmetry is concerned all the curves are not far from the normal type.

If we examine the degree of kurtosis*, measured by the deviation of β_2 from 3 in comparison with the probable error of β_2, it is evident that all the distributions except that for the breadth of the conjugants are mesokurtic within the limits of error from random sampling. The value of $3-\beta_2$ in the case of the breadth of the conjugants is almost certainly significant and indicates that the distribution is platykurtic, or in other words, is more "flat-topped" than the normal curve.

The value for $\sqrt{\beta_1}$ differs from zero by an amount which is certainly significant in the breadth distribution of conjugants, and probably significant for the breadth of non-conjugants. For the length distributions the values are insignificant. It should be noted that though in several cases the constants are insignificant in comparison with their probable errors when considered singly, yet the skewness, difference, and $\sqrt{\beta_1}$ for all but one the distributions show a deviation in the same sense. When we have a number of constants all pointing towards skewness rather than symmetry in the distributions we cannot safely say that as a whole the distributions are normal, even though each observed constant taken singly differs by something less than its probable error from its theoretical value. There is a cumulative effect of a number of like results, though each may be insignificant by itself.

We conclude then that while all these distributions deviate from the normal law the length distributions do not diverge greatly. The breadth distributions clearly demand skew curves for graduation. The breadth distribution of the conjugants belongs to Pearson's (*loc. cit.*) Type IV., while the same distribution for non-conjugants is of Type I.

It will be understood that these conclusions are not intended to be general but to apply only to the four cases discussed. As has been mentioned above, I hope later to discuss the whole question of variation in Paramecium with much more extensive material.

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* For the introduction of this term to express, in connexion with the prefixes lepto-, meso-, and platy-, the conditions as to the shape of a frequency curve in the region of the mode, cf. Pearson, K., *Biometrika*, Vol. IV. pp. 169—212.

V. *Differentiation of the Conjugant Population.*

When the measurements at Leipzig were begun the first point which attracted attention was the fact that, even to the eye the conjugant individuals were distinctly smaller than the non-conjugants living in the culture at the same time. When the measurements were reduced this fact of differentiation within the population was still more clearly shown. We may proceed now to examine its amount and nature. What evidently is required is a comparison of conjugants and non-conjugants with respect to means, variabilities and organic correlations, for each of the characters discussed, namely length, breadth and index. In order not to make too complex a table I shall treat each character separately, taking the length first in Table V. In this table there is given for each series the mean, standard deviation, and coefficient of variation for length in (*a*) non-conjugants and (*b*) conjugants; the absolute difference between the constants which is expressed as positive when the non-conjugant constant is larger, and negative when the conjugant is larger; the probable error of the absolute difference; and the relative difference defined as the percentage which the absolute difference is of the *non-conjugant* constant.

TABLE V.

Differentiation of Conjugants from Non-Conjugants in Length.

Series	Group	Means	Standard Deviations	Coefficients of Variation
A	Non-Conjugants ...	189·976 ± ·724	15·549 ± ·512	8·185 ± ·271
„	Conjugants ...	168·143 ± ·522	11·212 ± ·369	6·668 ± ·220
„	Absolute Difference	21·833 ± ·893	4·337 ± ·631	1·517 ± ·349
„	Relative „	11·5 °/ₒ	27·9 °/ₒ	18·5 °/ₒ
C	Non-Conjugants ...	209·356 ± ·906	19·099 ± ·641	9·123 ± ·309
„	Conjugants ...	176·015 ± ·621	13·094 ± ·439	7·439 ± ·251
„	Absolute Difference	33·341 ± 1·098	6·005 ± ·777	1·684 ± ·398
„	Relative „	15·9 °/ₒ	31·4 °/ₒ	18·5 °/ₒ
D	Non-Conjugants ...	217·656 ± 2·319	19·453 ± 1·640	8·937 ± ·759
„	Conjugants ...	181·906 ± 1·554	13·037 ± 1·099	7·167 ± ·607
„	Absolute Difference	35·750 ± 2·792	6·416 ± 1·974	1·770 ± ·972
„	Relative „	16·4 °/ₒ	32·98 °/ₒ	19·8 °/ₒ
B	Non-Conjugants ...	199·708 ± 1·890	13·727 ± 1·336	6·874 ± ·672
„	Conjugants ...	168·167 ± 2·242	16·285 ± 1·585	9·684 ± ·953
„	Absolute Difference	31·541 ± 2·932	− 2·558 ± 2·073	− 2·810 ± 1·166
„	Relative „	15·8 °/ₒ	18·6 °/ₒ	40·9 °/ₒ

We first notice the large differences between the means. Averaging for the four series the conjugants are 14·9 per cent. shorter than the non-conjugants living in the same culture at the same time. The absolute variability, measured by the standard deviation, averages in Series *A*, *C* and *D* (all from the same culture, it will be remembered) 30·8 per cent. lower in conjugants than in non-conjugants. Of course we should expect the standard deviations for conjugants to give lower values than for non-conjugants, because the conjugants have the lower mean values. Not all the difference, however, is due to this factor, as a glance at the coefficients of variation at once shows. From these it is seen that (averaging Series *A*, *C* and *D*) in proportion to size the conjugants are 18·9 per cent. less variable than the non-conjugants. Series *B* is in apparent contradiction to this conclusion regarding variability, since it gives a negative difference in both variability columns; that is, in this series, the conjugants are the more variable both absolutely and relatively. The probable errors show, however, that neither for standard deviations nor coefficients of variation are the differences significant. This Series *B*, for reasons stated above (p. 219), is a very short series, comprising only 12 pairs of conjugants, and a corresponding number of non-conjugants. As a matter of fact, within the large errors incident to such small random samples, conjugants and non-conjugants are equally variable in Series *B*. The means for this series are in good accord with the others, showing as they do a difference of 15·8 per cent. in favour of the non-conjugants.

I think then, that there can be but one conclusion from the facts set forth in Table V., viz. *that the Paramecia which are conjugating at a given time are markedly differentiated from the non-conjugant individuals living in the same culture at the same time in both type and variability. For the character length of body this differentiation is in the direction of lowered mean and variability for conjugants as compared with non-conjugants**.

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* *Note added Nov.* 10. Mr Lister (*loc. cit.*) in criticism of this conclusion says: "Now the non-conjugant population of the latter species [*Paramecium caudatum*] measured by Dr Pearl to ascertain the range (*sic*) of their variability would include, not only ordinary individuals, but all stages of individuals in process of differentiation as gametes. The non-conjugants are a heterogeneous population; the conjugants are, on the other hand, approximately homogeneous. This appears to me another and grave source of error in his results on the degree of differentiation and variability of the conjugants." My conclusions from the data presented in this paper are that conjugants are smaller in mean dimensions and less variable than non-conjugants. The first of these conclusions Mr Lister agrees to, because by searching the literature he has found that Maupas observed the same thing. If he had searched the literature a little more diligently he would have found that practically every one who has ever worked on conjugation in Paramecium has noted this fact. Finally if Mr Lister had himself ever carefully observed a culture of Paramecium in which conjugation was going on he would not have needed to go to the literature to learn that conjugant Paramecia are smaller than non-conjugant. To the second of my conclusions, viz., that conjugants exhibit lower variability than do individuals in fission generations Mr Lister objects that the non-conjugant populations measured were heterogeneous. In his opinion then the difference between the variation constants for conjugants and non-conjugants arises because the non-conjugant populations exhibit a spuriously high variability resulting from heterogeneity. Or in other words his contention is that a random sample of non-conjugant individuals from a culture in which conjugation is occurring will show higher variability than a random sample of

The facts regarding variation in length for the four series *A*, *C*, *D* and *E* are shown graphically in Diagram I. (pp. 234, 235). This will perhaps bring out more forcibly the facts of Table V. In the diagram we have the frequency distributions plotted to such scales that the *areas* of all are equal. The units of abscissae are microns of body length, and the ordinates give percentage frequencies. Beginning at the top the polygons are arranged in order of collection. Polygons for conjugants are drawn with continuous lines, those for non-conjugants with dotted lines.

The differences between conjugants and non-conjugants are made very evident by these diagrams. They also bring out clearly another point, namely the progressive change in the means as we pass from the beginning of the epidemic (Series *A*) to the end (Series *E*). The mean length of the conjugants increased, during the period from August 15 to August 30, 13·637 microns or 8·2 per cent. of the original mean. In the same way, during the period from August 15 to September 6 the mean length of the non-conjugants increased 24·494 microns, or

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"ordinary" Paramecia from a culture in which conjugation is not occurring. Now the worth of this contention can best be judged by an examination of the following table, which has been formed by rearranging the values given in Table II. (p. 226).

Coefficients of Variation for Paramecium.

A Conjugants	*B* Non-conjugants in cultures where conjugation was occurring	*C* "Ordinary" Paramecia of selected ancestry from cultures in which conjugation *never* occurred
6·668 (210)	8·185 (210)	8·736 (500)
7·439 (202)	9·123 (202)	8·292 (500)
—	8·529 (132)	8·772 (500)
—	—	9·345 (500)
—	—	9·030 (500)
—	—	7·359 (500)
Av. = 7·053	Av. = 8·612	Av. = 8·672

Now the "ordinary" Paramecia of this table (column *C*) were all of selected ancestry, i.e., were the resultants of the continued division of one single individual. Therefore we should expect them to show if anything reduced variability as compared with Paramecia of mixed ancestry. Further their entire cultural history, beginning with the original single individual, was known and in it conjugation did not occur. But our non-conjugants (column *B*) are *not*, as Mr Lister presumes that they are, more variable than are these "ordinary" individuals. They are on the whole about equally variable, as we should expect them to be. Finally it is clear from column *A* and other data given in the body of the paper that the variability of *conjugants* is of a totally different order from that of non-conjugants or "ordinary" Paramecia in fission generations. In the light of these figures based on the careful and painstaking measurements of large numbers of individuals I leave it to the reader to judge of the significance of Mr Lister's "grave source of error" in my results. R. P.

12·9 per cent. of the original mean[*]. These values give some idea of the great changes which are produced in Paramecium as a result of environmental influences. That this increase in mean length in the present case is due to environmental influences and is in no way connected with the conjugation epidemic is evidenced by the fact that the conjugants show an increase as well as the non-conjugants though not by so great an amount. Furthermore the same sort of change has been found in other cases[†]. Further discussion of this interesting and important matter of environmental influence on variation in Paramecium may be deferred for the present, as I hope to return to it in a special paper based on data collected *ad hoc*.

In connection with this increase of mean length during the period of examination, it will be noted that both the absolute and relative differences between conjugants and non-conjugants increase, being lowest for Series *A* and highest for Series *D*. In other words, the conjugants and non-conjugants are more differentiated from one another at the end of the conjugation epidemic than they were at the beginning. This is due to the fact that the environmental influences produce a greater effect on the non-conjugants than on conjugants. The significance of this fact on the theoretical side will be discussed later.

Examining the coefficients of variation in Table V., we see that the differences —both absolute and relative—are practically constant for all three series, *A*, *C*, and *D*. In other words, though the means of both conjugants and non-conjugants increase, the amount of variation in proportion to the size does not sensibly change. This seems to be a rather important result, when it is remembered that Series *C* and *D* must have included among the non-conjugants measured a larger proportion of recent ex-conjugants than did Series *A*. It points distinctly to the conclusion that the biological significance or purpose of the conjugation process is not to bring about increased variability. Because, clearly, if conjugation were followed by greater variation in the ex-conjugants, we should expect the non-conjugant distributions of series *C* and *D* (containing more ex-conjugants) to differ sensibly more from the conjugant distributions in variability than does that of series *A*. Furthermore, if we compare the coefficient of variation for length of series *E* ($= 8·529 \pm ·357$) with the values of the same constant for the non-conjugants of series *A*, *C* and *D* ($= 8·185 \pm ·271$, $9·123 \pm ·309$ and $8·937 \pm ·759$ respectively), it clearly is not significantly greater. But the individuals of series *E* must have been, in considerable proportion, ex-conjugants. Putting all the results together, there seems no doubt that the primary significance of conjugation is not to produce variability, whatever else it may be.

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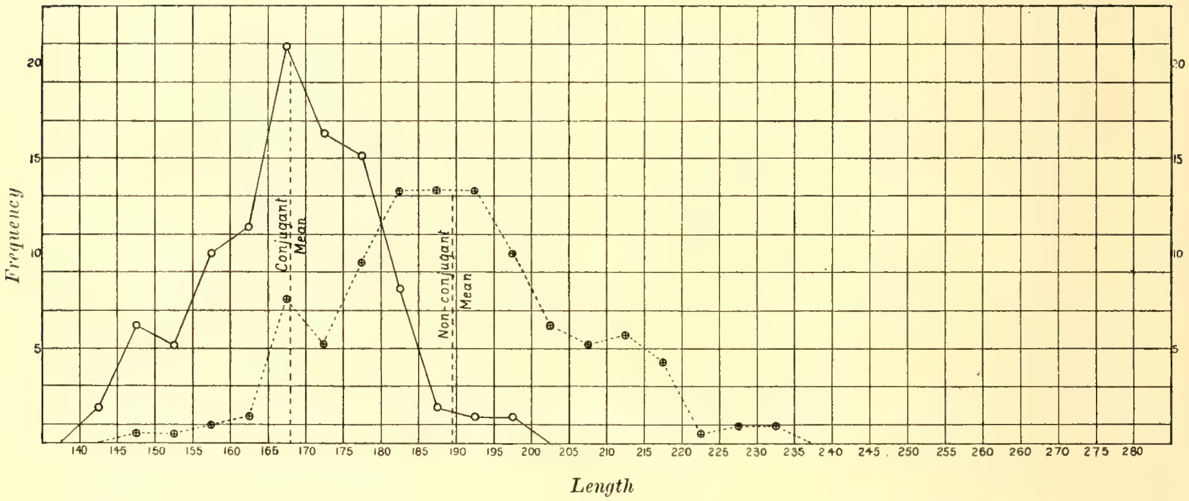
[*] The increase, is of course, apparently somewhat greater in the case of the non-conjugants if we take only the period to August 30th, thus making *D* the last series, since Series *D* shows a slightly higher mean than Series *E*. Since, however, *D* is such a short series it seems likely that we shall come nearer the actual facts by taking the mean of Series *E* to represent the maximum for the period and culture under discussion. In any event the difference between the means of series *D* and *E* for length is not significant in comparison with its probable error.

[†] Cf. Pearl, R., and Dunbar, F. J., *loc. cit.*

Series *A*. August 15th—18th.



Series *C*. August 24th—26th.

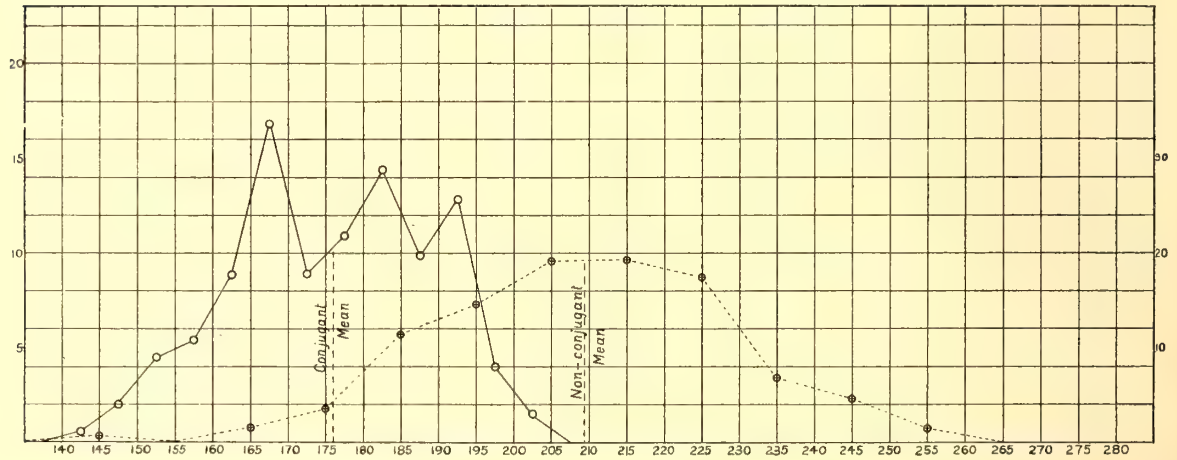
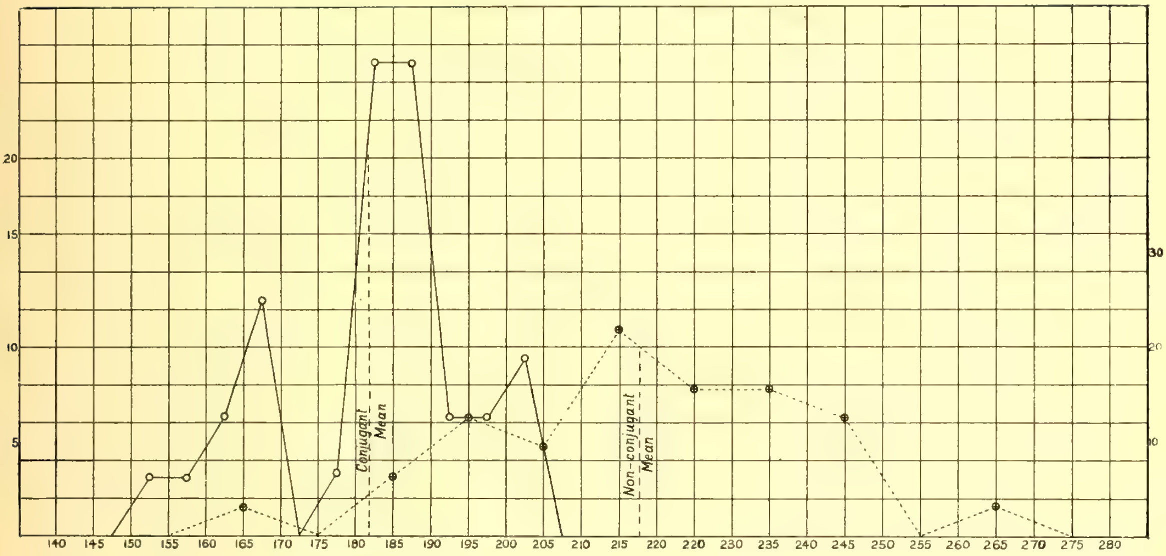
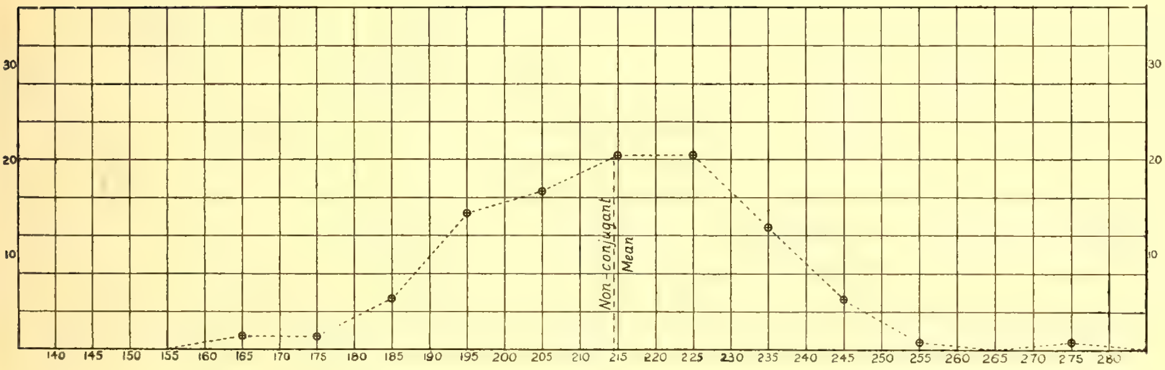


Diagram I. Frequency polygons for variation in length in Series *A*, *C*, *D* and *E*. Continuous lines = conjugants. Dotted lines = non-conjugants. On the left margin are given the scales of frequency for the continuous line polygons, and on the right margin those for the dotted line polygons.

Series *D.* August 30.



Series *E.* September 6.



We may turn now to the character breadth, for which Table VI. has been formed on exactly the same plan as Table V. for length, except that the short series B and D are not included. They show essentially the same relations as A and C and, in view of the small number of individuals, it seems hardly worth while to publish the results from them in detail.

TABLE VI.

Differentiation of Conjugants from Non-Conjugants in Breadth.

Series	Group	Mean	Standard Deviation	Coefficient of Variation
A	Non-Conjugants ...	52·827 ± ·273	5·870 ± ·193	11·112 ± ·370
,,	Conjugants ...	44·371 ± ·194	4·170 ± ·147	9·398 ± ·312
,,	Absolute Difference	8·456 ± ·335	1·700 ± ·237	1·714 ± ·484
,,	Relative ,,	16·0 °/₀	28·96 °/₀	15·4 °/₀
C	Non-Conjugants ...	54·208 ± ·280	5·905 ± ·198	10·894 ± ·370
,,	Conjugants ...	43·158 ± ·162	3·414 ± ·115	7·910 ± ·267
,,	Absolute Difference	11·050 ± ·324	2·491 ± ·229	2·984 ± ·456
,,	Relative ,,	20·4 °/₀	42·2 °/₀	27·4 °/₀

From this table it is seen that in breadth the same kind of differences occur between conjugants and non-conjugants as have already been found for length. The conjugants are markedly narrower, and less variable in this character than the non-conjugants. In no case is there any doubt about the difference between conjugants and non-conjugants being significant. The differences are proportionately somewhat larger for breadth than for length, but it should be kept in mind that a part of this excess in relative breadth differences, has the simple explanation that the conjugants have their oral surfaces somewhat flattened, as a result of the union (see above, p. 222). This results in an artificial lowering of the mean and variability in the breadth distributions for conjugants.

Some information regarding the extent of this decrease in breadth due to the conjugation process itself may be gained if we look at the matter in another way. Assume, for the moment, that the selection of conjugants is a selection based on length alone, and that breadth is only different in conjugants from what it is in non-conjugants because it is organically correlated with length. Then clearly the mean breadth of conjugants would be the same as the mean breadth of a group of non-conjugants having the same mean length as the conjugants. Now, for series A and C, the characteristic equations[*] relating breadth to length in the non-conjugants are as follows:

Series A, Non-conjugants. $B = {}^{\cdot}2224L + 10{\cdot}576$, P.E. $= 3{\cdot}199$,
,, C, ,, $B = {}^{\cdot}1897L + 14{\cdot}493$, P.E. $= 3{\cdot}145$,

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[*] These are calculated by well-known methods given by Pearson, *Phil. Trans.* Vol. 187 A, pp. 253—318, and also in convenient form by Yule, *Jour. Roy. Stat. Soc.* Vol. 60, pp. 1—44.

where B signifies breadth in microns and L signifies length in microns. The probable errors of determinations made by these equations are given in microns.

If now, we substitute, for L in these equations the mean length of the conjugants in series A and C respectively and solve for B, we shall get the probable mean breadth of a group of non-conjugants selected to the same mean length as the conjugants. This has been done with the following results:

Series A, Mean Breadth predicted = 47·971 microns,
„ „ „ observed = 44·371 „

Difference = 3·600 „

Series C, Mean Breadth predicted = 47·883 microns,
„ „ „ observed = 43·158 „

Difference = 4·725 „

Now these differences, which in view of the probable errors of the determinations are barely sensible, must represent the sum total of decrease in mean breadth due to (a) direct selection of breadth, provided it occurs, and (b) shrinkage of the breadth dimension measured due to the conjugation process itself. We know from direct observation that (b) occurs and, as will be brought out as we go on, there is no evidence that (a) occurs at all. Hence it seems to me not unlikely that these differences represent practically solely the changes in the oral-aboral breadth dimension due to the conjugation process itself as explained above.

Another interesting point which comes out of Table VI. is that, as we pass from Series A to Series C, there is no increase in the mean breadth corresponding to the increase in length due to environmental influences. The non-conjugants, it is true, show a slight increase (= 1·381 microns), but this is hardly significant in view of the probable error. The conjugants show a decrease of about the same amount. In other words, it is seen that the environmental change which occurred in the culture during the time between the taking of Series A and Series C caused an increase in mean length but not in mean breadth, so consequently the shape was changed, the individuals becoming more slender. This point will be discussed further in connection with the indices.

We may now turn to a consideration of the length-breadth index for conjugants and non-conjugants. Table VII. has been prepared for this character in the same way that Table VI. was for breadths. For the same reasons as before, only Series A and C are included.

This table brings out more clearly several results which have been reached by examination of the lengths and breadths alone. In the first place it is seen that the non-conjugants have a higher mean index in both cases than do the conjugants, but the difference is not great. In other words, as was concluded above, the conjugants are narrower in proportion to their length than the non-conjugants, due to the flattening of the conjugants as a result of the union.

TABLE VII.

Differentiation of Conjugants from Non-Conjugants. Index.

Series	Group	Mean	Standard Deviation
A	Non-Conjugants ...	27·848 ± ·116	2·502 ± ·082
"	Conjugants ...	26·338 ± ·126	2·697 ± ·089
"	Absolute Difference	1·510 ± ·171	– ·195 ± ·121
"	Relative "	5·4 %	7·8 %
C	Non-Conjugants ...	25·911 ± ·106	2·238 ± ·075
"	Conjugants ...	24·495 ± ·113	2·390 ± ·080
"	Absolute Difference	1·416 ± ·155	– ·152 ± ·110
"	Relative "	5·5 %	6·8 %

We also note that, in passing from Series *A* to Series *C*, the index is lowered for both conjugants and non-conjugants about two points (actually the difference for non-conjugants is 1·937 and for conjugants 1·843). The individuals in the culture at the time Series *C* was taken have become narrower in proportion to length than they were when Series *A* was taken.

After Series *C* was taken from the culture the environmental conditions changed rapidly, and with this change, as has been mentioned, a vigorous growth of algae began. At the same time the shape of the Paramecia changed markedly in the reverse direction to the change which had occurred in the interval between Series *A* and *C*. Thus in Series *E* the index (for non-conjugants, of course,) had risen to a mean value of 29·508 ± ·125, and the variability of the index had decreased to 2·132.

The variabilities of the indices show a relation which at first sight appears paradoxical. In both series the index is more variable in the conjugants than in the non-conjugants, in spite of the fact that both length and breadth, on which the indices are based, are more variable in the non-conjugants. This greater variability of the index in the conjugants, however, really arises from the fact that, as we shall see, the coefficient of correlation between length and breadth is much lower in the conjugants than in the non-conjugants. This point will be much clearer if we consider the general formula for the standard deviation of an index. It has been shown by Pearson* that if x_1 and x_3 be the absolute sizes of two correlated characters, v_1 and v_3 their coefficients of variation $\frac{\sigma_1}{m_1}$, $\frac{\sigma_2}{m_2}$, r_{13} the coefficient of correlation between x_1 and x_3, and i_{13} be the mean value of the index $\frac{x_1}{x_3}$, and Σ_{13} its standard deviation, then

$$\Sigma_{13} = i_{13}\sqrt{(v_1^2 + v_3^2 - 2r_{13}v_1v_3)} \quad \text{.........................(i).}$$

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* *Roy. Soc. Proc.* Vol. 60, p. 492.

Now it is quite clear that for any given values of v_1 and v_3 the value of the expression under the radical will decrease as r_{13} increases. In our present case the excess of the non-conjugant coefficients of variability over those for the conjugants is not great enough to overbalance the tendency of the high non-conjugant r_{13} to lower the value of Σ_{13}. This is quite clear if we arrange for a single case (Series *A*) the value of each term in equation (i) in parallel columns for conjugants and non-conjugants. Doing this, we have the following results:

Term	Conjugant	Non-Conjugant
i_{13}	26·338	27·848
v_1^2	88·303609	123·476544
v_3^2	44·462224	66·994225
$2r_{13}$	·5566	1·1780
$2r_{13}v_1v_3$	34·879840	107·141126
$v_1^2+v_3^2$	132·765833	190·470769
$v_1^2+v_3^2-2r_{13}v_1v_3$	97·885993	83·329643

So then we have for the conjugants

$$\Sigma_{13} = \frac{26{\cdot}338 \times 9{\cdot}8937}{100} = 2{\cdot}6058,$$

and for the non-conjugants

$$\Sigma_{13} = \frac{27{\cdot}848 \times 9{\cdot}1285}{100} = 2{\cdot}5421.$$

The values obtained by direct calculation from the index distributions are 2·697 and 2·502 respectively. The values from the formula are thus in very fair agreement with those from the frequency distributions directly, considering that the constants were taken only to three places of decimals.

It is quite clear, then, that it is the higher value of r_{13} for the non-conjugants which brings down the value of Σ_{13} for that group. Series *C* shows the same relation.

We may now turn to the organic correlations. Besides the correlation of length with breadth, the correlation of the index with length and with breadth will be considered. In Table VIII. are collected all the determinations so far made of the correlation between length and breadth of body in Paramecium. The upper portion of the table is arranged on the same plan as Tables V., VI. and VII. to bring out the differences between conjugants and non-conjugants in respect to degree of correlation between length and breadth. The constant tabulated is the well-known coefficient of correlation, *r*. In the column headed "Table" is given the number of the table in the Appendix, from which each value of *r* was calculated.

TABLE VIII.

Correlation between Length and Breadth of Body in Paramecium.

Series	Group	r	Number	Table
A	Non-Conjugants ...	·5890 ± ·0304	210	*A* 2
"	Conjugants ...	·2783 ± ·0429	210	*A* 1
"	Absolute Difference	·3107 ± ·0526	—	—
"	Relative "	52·7 °/。	—	—
C	Non-Conjugants ...	·6135 ± ·0296	202	*C* 2
"	Conjugants ...	·2063 ± ·0454	202	*C* 1
"	Absolute Difference	·4072 ± ·0542	—	—
"	Relative "	66·4 °/。	—	—
E	Non-Conjugants ...	·6787 ± ·0317	132	*E* 1
AA	Conjugants *A* ...	·3952 ± ·0402	200	*AA* 1
"	" *B* ...	·3728 ± ·0411	200	*AA* 2
Simpson's	Non-Conjugants ...	·421 ± ·055	100	—

The table shows that the organic correlation between length and breadth of body in Paramecium is rather high and in all cases positive, or in other words, with an increase in length is associated an increase in breadth. If we consider for a moment only the non-conjugants, the coefficient is in every case greater than ·5. This emphasizes the fact, which has been mentioned before, that the shape of the body in this infusorian is relatively constant and definite. That the coefficients are not, however, unduly high for such an organism is indicated by the fact that in material on variation in the flagellate infusorian *Chilomonas paramecium**, the coefficient of correlation of length with breadth is in two fairly extensive series almost exactly equal to that found for the non-conjugant Paramecia of Series *C*. In this connection, I think we must conclude that Simpson's value for the length-breadth correlation is probably not to be considered as typical for normal Paramecia. It is too low, probably due to the fact that his individuals were measured shortly after fission had occurred. We have what is perhaps a parallel instance in the present series in the very marked lowering of the conjugant correlations. I am inclined to think that the typical or normal value for the correlation between length and breadth of body in Paramecium is not far from ·6.

In order to help to an understanding of the degree of relationship implied by correlation coefficients of the magnitude we have found for the length and breadth of non-conjugant Paramecia, I have formed Table IX., which gives for purposes of comparison a series of coefficients for different organs and characters.

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* Cf. *Biometrika*, Vol. v. pp. 64 *et seq.*

TABLE IX.

Comparison of Values of the Correlation Coefficient for Various Characters.

Organism	Correlated Characters	r
Actinospherium* ...	Number of cysts and size of body	·7692
" ...	" " nuclei " "	·8540
" ...	" " cysts " cysts	− ·6689
Arcella †	Diameter of shell and diameter of opening	·836
Paramecium	Length and breadth, mean of all non-conjugants ...	·6271
Daphnia ‡	Body length and cell length (Hatching to 3rd moult)	·5505
"	" " " (3rd to 4th moult) ...	·3930
"	" " " (After 4th moult) ...	·2477

The regressions for the length-breadth correlations are sensibly linear in the present samples. To show the nature of the regression, Diagrams II. and III. have been prepared§. Diagram II. gives the regression for breadth on length in the case of the conjugants, and Diagram III. the same for the non-conjugants, of Series *A*.

Series *A*.

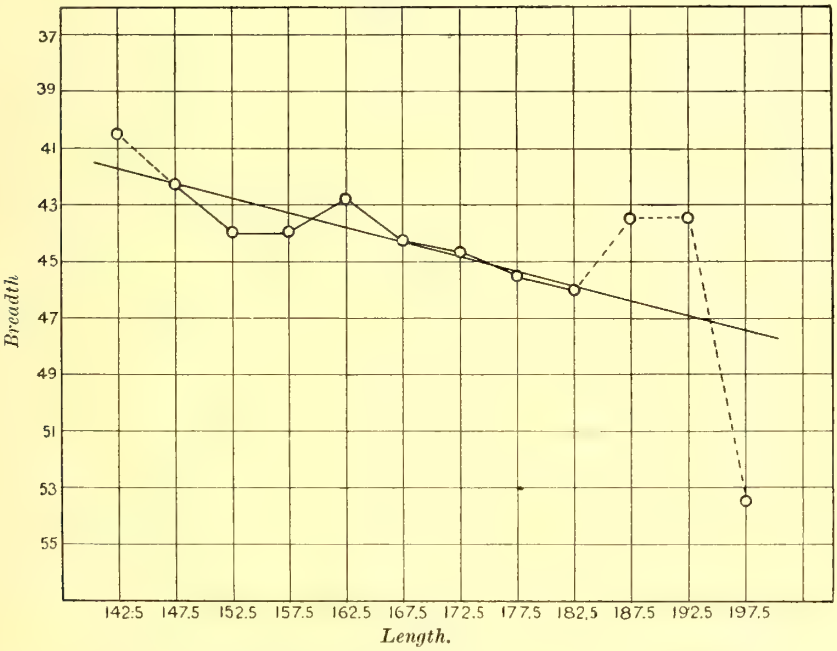

DIAGRAM II. Regression of breadth on length for the conjugants of Series *A*.

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[*] Smith, G. *Biometrika*, Vol. II. pp. 243, 246.

[†] Pearl, R., and Dunbar, F. J. *Ibid.* Vol. II. p. 330.

[‡] Warren, E. *Ibid.* Vol. II. p. 258.

[§] In the regression diagrams of this memoir, a broken line links points depending on too few observations to be reliable. The absence of any line between two points marks a total failure of intervening observations.

Series *A*.

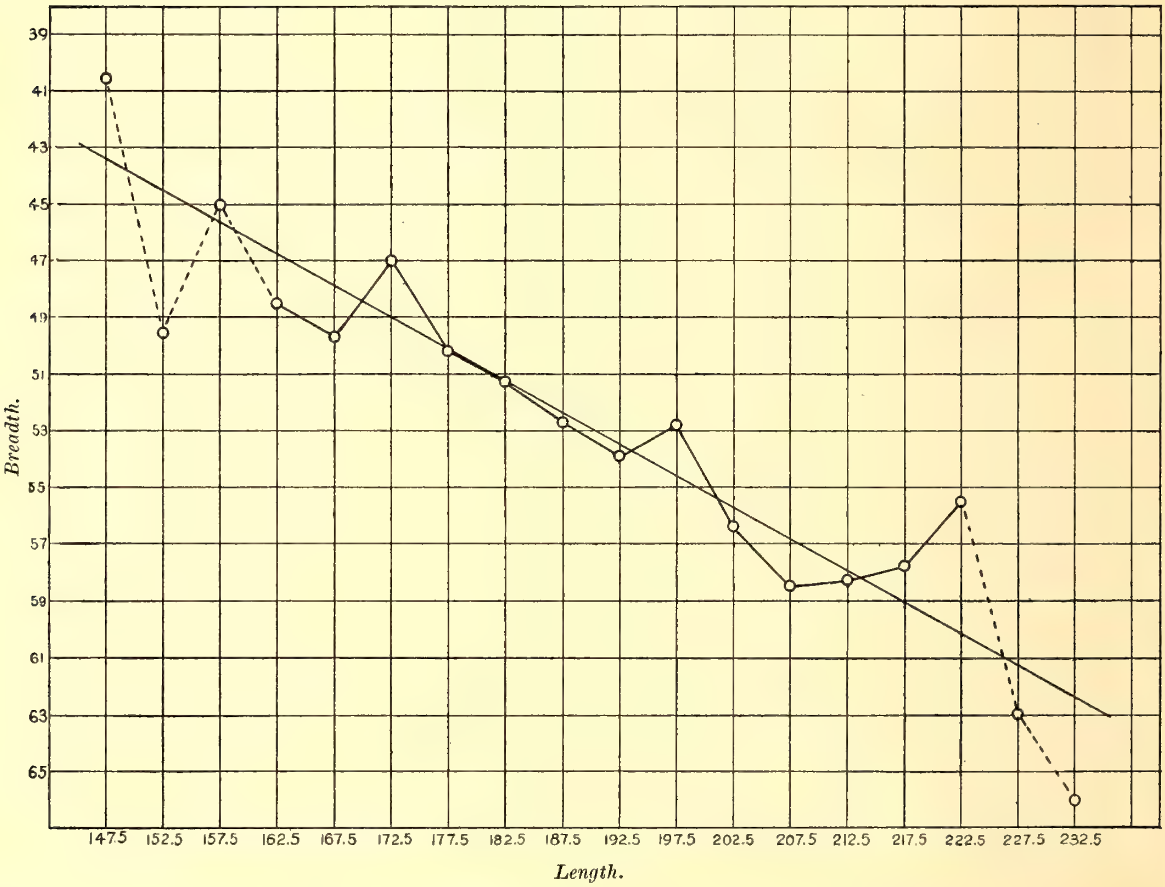

DIAGRAM III. **Regression of breadth on length for the non-conjugants of Series *A*.**

Considering the relative smallness of our total numbers, a straight line gives a very good fit to the means of the arrays.

Returning to Table VIII., we see that in both Series *A* and *C* the conjugants have length and breadth much less highly correlated than have the non-conjugants. The lowering of the correlation I believe to be due principally to the change in shape which results from the union of the individuals in the conjugation process. Also, the element of difficulty in measuring the breadth of conjugants (cf. *supra*, p. 222) would operate to lower the length-breadth correlations.

The increase in the value of the length-breadth correlations for the non-conjugants as we pass from Series *A* to Series *E* is also to be noted. This again marks the change in the variation constants accompanying the change in environmental conditions in the culture.

We may turn now to the index correlations. For Series *A*, *C* and *E* there have been determined the correlation of the length-breadth index with length and with breadth for both conjugants and non-conjugants. These index correlations were all calculated by formula, and not from tables directly. That the formula gives very close results for such correlations has been pointed out by several workers, notably C. D. Fawcett* and Macdonnell†. Pearson‡ has shown that in terms of the organic correlations $r_{12} \ldots r_{34}$, and the coefficients of variation $v_1 \ldots v_4$ of four variable characters, $x_1 \ldots x_4$, the coefficients of correlation ρ between the two indices $\frac{x_1}{x_3}$, and $\frac{x_2}{x_4}$ has the value

$$\rho = \frac{r_{12}v_1v_2 - r_{14}v_1v_4 - r_{23}v_2v_3 + r_{34}v_3v_4}{\sqrt{v_1^2 + v_3^2 - 2r_{13}v_1v_3}\sqrt{v_2^2 + v_4^2 - 2r_{24}v_2v_4}} \quad \text{..................(i).}$$

In the present instance it is desired to correlate the length-breadth index x_1/x_3 with first length x_3, and then breadth x_1. For the index-length correlation substituting the proper value in (i) we get

$$\rho = \frac{r_{13}v_1 - v_3}{\sqrt{v_1^2 + v_3^2 - 2r_{13}v_1v_3}} \quad \text{.............................(ii).}$$

In the same way for the index-breadth correlation we have

$$\rho = \frac{v_3 - r_{13}v_3}{\sqrt{v_1^2 + v_3^2 - 2r_{13}v_1v_3}} \quad \text{.............................(iii).}$$

In the values of ρ in each instance there are clearly two factors, (*a*) the true organic correlation arising from the existence of an organic correlation r_{13}, and (*b*) the spurious correlation between the index and the characters concerned. The expression for the spurious correlation in the case of the index-length correlation is

$$\rho_0 = \frac{-v_3}{\sqrt{v_1^2 + v_3^2}} \quad \text{....................................(iv),}$$

and that for the index-breadth correlation is

$$\rho_0 = \frac{v_3}{\sqrt{v_1^2 + v_3^2}} \quad \text{....................................(v).}$$

The latter differs from (iv) only in being positive where that is negative. In the following Table X. there are given in the column headed "Gross" the values calculated from formulae (ii) and (iii), i.e. the values for ρ. In the column headed "Spurious" are given the values of ρ_0 calculated from (iv) and (v), and finally in the column headed "Net" we have the portion of the gross correlation due to true organic correlation between the index and the character, or in other words, the value tabulated in this column is $\rho - \rho_0$.

The results from the index correlations are rather remarkable. In spite of the fact that the index is formed by taking 100 times the breadth divided by the length, the *net organic correlation* of index with length is in every case *positive*,

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* *Biometrika*, Vol. I. p. 461.

† *Ibid.* Vol. III. p. 238.

‡ *Proc. Roy. Soc.* Vol. 60, p. 493.

TABLE X.

Index Correlation in Paramecium.

Series	Group	Characters	Gross	Spurious	Net	No.
A	Conjugants ...	Index and Length	– ·4096 ± ·0387	– ·5804 ± ·0309*	·1708 ± ·0452*	210
"	"	" Breadth	·4864 ± ·0355	·5804 ± ·0309	– ·0940 ± ·0461	210
"	Non-Conjugants	" Length	– ·1797 ± ·0450	– ·5931 ± ·0302	·4134 ± ·0386	210
"	" "	" Breadth	·3685 ± ·0402	·5931 ± ·0302	– ·2246 ± ·0442	210
C	Conjugants ...	Index and Length	– ·6002 ± ·0304	– ·6851 ± ·0252	·0849 ± ·0471	202
"	"	" Breadth	·6102 ± ·0298	·6851 ± ·0252	– ·0749 ± ·0472	202
"	Non-Conjugants	" Length	– ·2728 ± ·0439	– ·6420 ± ·0279	·3692 ± ·0410	202
"	" "	" Breadth	·3943 ± ·0401	·6420 ± ·0279	– ·2477 ± ·0445	202
E	Non-Conjugants	Index and Length	– ·3263 ± ·0525	– ·6819 ± ·0314	·3556 ± ·0513	132
"	" "	" Breadth	·3855 ± ·04998	·6819 ± ·0314	– ·2964 ± ·0535	132

while that for index and breadth is in every case *negative.* In the case of the conjugants for both series the net index-breadth values are probably not significant. The spurious values are very high and of roughly the same order of magnitude in all cases. Just as where the characters length and breadth are considered separately, the correlations are here always higher for non-conjugants than for conjugants. It is also quite clear, considering the net organic relationship, that the index is throughout more highly correlated with length than with breadth. There would appear to have been no significant change in the index correlations during the history of the culture.

As there seems to be some doubt in the minds of many biologists as to whether the expression $\rho - \rho_0$, measuring the portion of a gross index correlation due to the organic correlation of the characters entering into the index, has any real significance, or if it has, what this significance is, I have prepared the two diagrams which follow with the hope that they may make the matter somewhat clearer. It seems to me that the difficulty regarding the expression $\rho - \rho_0$ comes largely from the fact that biologists usually think of correlation in terms of regression, and the effect of spurious correlation has not hitherto, so far as I know, been expressed in those terms. Diagrams IV. and V. bring out this relation quite clearly. The plan on which these diagrams have been constructed is as follows; in the first place the characteristic equation showing the actually observed relation of index to length was calculated for a particular group (the conjugants of Series A). This characteristic equation is the equation to the regression line which one would actually observe if one made a correlation table of index and length. In calculating it from the usual expression $b_{xy} = r_{xy}\frac{\sigma_x}{\sigma_y}$, r_{xy} was put equal to the observed ρ, or gross index correlation; σ_x was the observed standard deviation of index and σ_y the observed standard deviation of length. Then by the usual method a characteristic equation in terms of the units of measurement was formed. In the case of the conjugants of Series A this characteristic equation took the form

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* It should be stated that the probable errors tabled in the "spurious," and "net" columns were calculated from the formula P.E. of $r = \cdot 67449 \frac{1-r^2}{\sqrt{N}}$. This procedure assumes that the coefficients are actual coefficients of correlation obtained from tables by the formula $r = \frac{Sxy}{N\sigma_1\sigma_2}$, which, of course, is not the case. In all probability the probable errors as given in the table are not widely divergent from the true values.

$$I = 42{\cdot}9018 - {\cdot}0985L,$$

in which I denotes the probable mean index of an array of type L in length. This line was then plotted on decimal paper. The next step was to calculate for the same group what may be called the spurious regression of index on length, on the assumption that there is no correlation between length and breadth. The equation for this spurious regression coefficient we may write as $b_{xy_0} = r_{xy_0}\frac{\sigma_{x_0}}{\sigma_y}$, in which $r_{xy_0} = \rho_0$, the "spurious" coefficient, and σ_{x_0} is the standard deviation of the "spurious" index distribution. This standard deviation is calculated from the usual formula for the standard deviation of an index*

$$\Sigma_{13} = i_{13}\sqrt{(v_1^2 + v_3^2 - 2r_{13}v_1v_3)},$$

by putting the organic correlation between length and breadth equal to 0. For the case in hand $r_{xy_0} = -{\cdot}1571$. Forming the regression equation and remembering that it will pass through a mean of its own given by the equation

$$i_{xy_0} = \frac{m_1}{m_3}(1 + v_3^2),$$

in which m_1 and m_3 are the observed mean breadth and length respectively and v_3 is the coefficient of variation for length we get

$$I_0 = 52{\cdot}9236 - {\cdot}1571L.$$

This is the equation of the regression line for index on length when there is no organic correlation of length with breadth. This was plotted to the same scale as the gross regression line, and the two lines are exhibited in Diagram IV. We see at once that, on account of the organic correlation between index and length, apart from the correlation between length and breadth, the regression line AB is pulled around through the shaded area to the position $A'B'$ in the direction of the arrows. The amount and direction of this change is always given by the expression $b_{xy} - b_{xy_0}$, so that we may say that the shaded area in the diagram is in each case the graph of what has taken place owing to $\rho - \rho_0$ differing from zero.

Diagram V. was prepared in exactly the same way and plotted to the same scale but represents the facts for the index-length correlation in the non-conjugants of Series A. Comparing the two diagrams we see that the effect of organic relationship between index and length is much greater in amount in the non-conjugants than in the conjugants.

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* Pearson, *loc. cit.*

Series *A*.

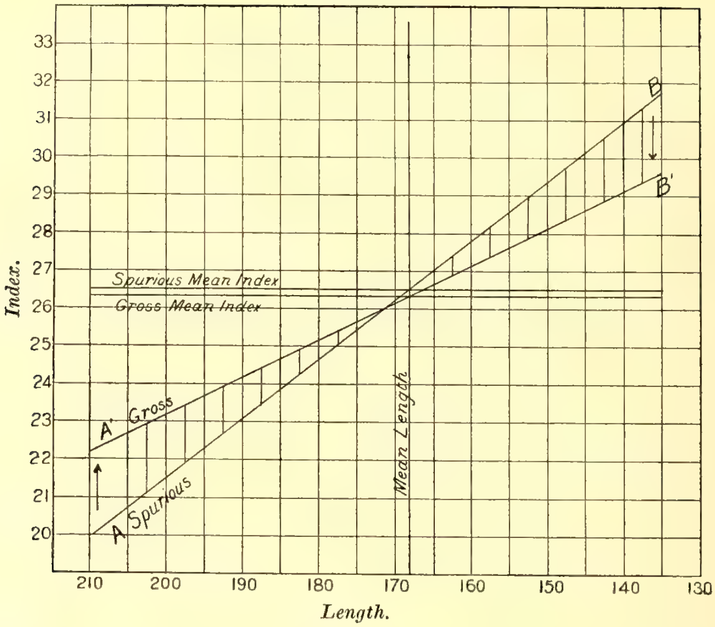

DIAGRAM IV. Showing the relation of the index-length correlations for conjugants of series *A*. *AB* is the regression line of index on length when all correlation between length and breadth in the individual is destroyed. It is the regression line for the *spurious* correlation between index and length *A'B'* is the "gross" or observed line of regression of index on length. The shaded portion shows the area through which the "spurious" line is moved (in the direction of the arrows) as a result of the existence of an organic correlation between length and breadth in the individual.

Series *A*.

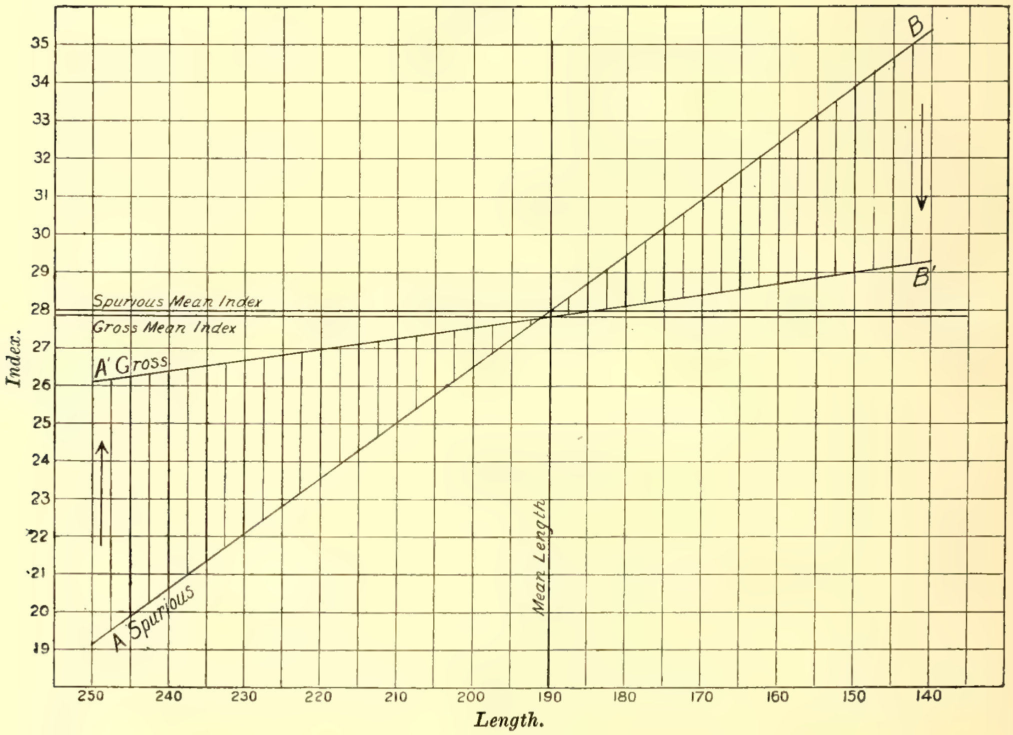

DIAGRAM V. Showing the relation of the index-length correlations in the non-conjugants of Series *A*. The significance of the letters is the same as in Diagram IV.

In order to bring out in another way the two facts of (*a*) environmental change during the history of the culture, and (*b*) the differentiation of conjugants from non-conjugants I have prepared the following regression tables showing the relation between the three characters length, breadth and index. In order to avoid too many decimals I have multiplied all the regression coefficients by 10. Apart from this the tables are self-explanatory.

TABLE XI.

Regression Table. Series A.

Conjugants.

Corresponds to a probable change in	Unit change of		
	10 microns in length	10 microns in breadth	10 % in index
Length ...	10μ	7·483μ	−17·031μ
Breadth...	1·035μ	10μ	7·522μ
Index ...	−·985 %	3·145 %	10 %

Non-Conjugants.

Corresponds to a probable change in	Unit change of		
	10 microns in length	10 microns in breadth	10 % in index
Length ...	10μ	15·602μ	−11·170μ
Breadth...	2·224μ	10μ	8·647μ
Index ...	−·289 %	1·570 %	10 %

TABLE XII.

Regression Table. Series C.

Conjugants.

Corresponds to a probable change in	Unit change of		
	10 microns in length	10 microns in breadth	10 % in index
Length ...	10μ	7·913μ	−32·879μ
Breadth ...	·537μ	10μ	8·715μ
Index ...	−1·096 %	4·273 %	10 %

Non-Conjugants.

Corresponds to a probable change in	Unit change of		
	10 microns in length	10 microns in breadth	10 % in index
Length ...	10μ	19·842μ	−23·276μ
Breadth ...	1·897μ	10μ	10·402μ
Index ...	− ·320 %	1·495 %	10 %

TABLE XIII.

Regression Table. Series E.

Non-Conjugants.

Corresponds to a probable change in	Unit change of		
	10 microns in length	10 microns in breadth	10 % in index
Length ...	10μ	21·454μ	−27·994μ
Breadth ...	2·147μ	10μ	10·463μ
Index ...	− ·380 %	1·420 %	10 %

These tables show very clearly the relation of the different characters in the different series. It will be noted that with a given change in either length or breadth roughly about twice as great a probable change in the associated character (breadth or length) occurs in the non-conjugants as in the conjugants. This is primarily the result of the higher correlation between length and breadth in the non-conjugants. On the other hand the index changes less with a given change in length or breadth in the non-conjugants than in the conjugants. This means that the shape as measured by the index is more constant with changing lengths and breadths in non-conjugants than in conjugants. In all cases, as we should expect, a unit change in breadth makes a larger change in the index than a unit change in length.

We may now summarize the results of this section as follows. It has been found that in several samples taken at different times from two different cultures there is a pronounced differentiation between conjugant and non-conjugant Paramecia living in the same culture at the same time, in respect to type, variability and organic correlation. *The conjugant individuals when compared with the non-conjugant are found to be shorter and narrower, and less variable in both length and breadth. The conjugants have a lower mean index, or in other words are relatively more slender, and are more variable in shape of body as indicated both by the length-breadth index and by the organic correlation between length and breadth. The conjugants have the length and breadth less highly correlated than the non-conjugants.* I would especially emphasize the fact that the differences here enumerated are by no means small and of doubtful character, but are, on the contrary, of large and significant amount. The difference in size between conjugants and non-conjugants is perfectly obvious to the eye without any measuring, if one's attention is only called to the matter. The differences here are quite as great or even greater than those which distinguish the most divergent races of men, for example, in the character stature. This point is dwelt upon lest someone might hastily conclude that the differentiation found between conjugants and non-conjugants was something dependent on the proper kind of figure-juggling. The discussion of the biological significance of this differentiation will be left to a later section of the paper, where all the results may be taken as a whole.

During a period in the history of a single culture, occupying about four weeks in time, definite and significant changes occurred in the type of the non-conjugant Paramecia. Similar changes occurred in the conjugants but were smaller in amount. Up to within a week of the dying out of the Paramecia the individuals became, as time went on, longer, without a corresponding increase in breadth. As a consequence the body became relatively slenderer in shape. The relative variability of the characters remained constant throughout this period. During the last week of the cultural history the individuals became broader again.

VI. *Assortative Mating in Conjugation.*

We come now to the consideration of the problem which originally led to the taking up of this work. This problem was: Is there any definite tendency for individuals relatively alike in size to conjugate with one another? It seemed to me at the outstart that though conscious choice, or any selection factor depending on a sexual differentiation, were obviously out of court, yet theoretically it was by no means impossible that a sensible degree of correlation between conjugants might exist. Thus the nature of the conjugation process itself made it seem possible if not probable that the two individuals in a conjugant pair must reasonably well "fit" one another if the conjugation were to be successful. Also it was not at all difficult to conceive that this sorting out of "fitted" pairs might be accomplished in a perfectly mechanical way when Jennings'* work on the reaction of the organism was considered. The difficulty of course came in conceiving that the "fit" of the two individuals would have to be any better, to ensure successful conjugation than we should in the long run get by pairing altogether at random individuals in the same culture. It seemed to me altogether likely that this condition was what actually existed, and I fully expected when the work was begun to find that putting together at random pairs of individuals would lead to just as high a coefficient of correlation between the members of the pairs as we should find from actual conjugants. How far from the facts this expectation was, the results which follow will show. The plan which was adopted to reach a solution of this question of assortative pairing was to determine by actual measurement the degree of correlation between the same and different characters in conjugated pairs and then to determine by experimentally pairing at random the records for these same individuals what degree of correlation we have between the individuals of a pair when there is no assortative mating whatever. Also it seemed desirable to find out what would be the result of putting together at random pairs of non-conjugants and pairs in which one individual was a conjugant and the other a non-conjugant.

A word should be said regarding the practical methods followed in this portion of the work. The first point which needs attention is one regarding the order of entry of individuals into the correlation tables. Suppose we call the individual of each conjugating pair which was the first to be measured A, and the individual of the pair last measured B. Then if, as was actually the case, there is no selection of the first individual to be measured on the basis of size characters, but instead the choice of A is quite accidental, then clearly the biometric constants for the A individuals ought not to differ significantly from those for the B individuals. As a matter of fact they did not differ significantly. Consequently it is a matter of indifference, so long as we are dealing with the same character in both members of the pair, whether A or B is entered into the correlation table as the first variable.

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* Various papers in *Amer. Jour. Physiol.*, *Amer. Naturalist*, *Amer. Jour. Psychol.*, etc. Specially for the reactions preceding conjugation, cf. *Jour. Comp. Neurol. and Psychol.* Vol. xiv. pp. 441—510.

Obviously then the proper thing to do is to enter each pair twice, once with A as the first variable and once with B as the first. This will result in making the table symmetrical* with the totals for the rows and columns equal. In each case in the present paper I have first formed correlation tables with A as the first variable, and deduced from each such table its correlation coefficient r. Then in those cases where we were dealing with the same character in both individuals of the pair the tables were made symmetrical and the coefficients of correlation again calculated. In the case of the symmetrical tables the coefficient was not calculated directly from the table but by a formula which is derived from a more general theorem given by Pearson† for determining the effect on the frequency constants of adding together different samples of material. He shows that if we let x and x' be measures of two organs, and there be N pairs of organs formed by i heterogeneous groups containing n_1, n_2, n_3, ... etc., pairs with means $m_1, m_1', m_2, m_2', m_3, m_3'$, ... etc., standard deviations $\sigma_1, \sigma_1', \sigma_2, \sigma_2', \sigma_3, \sigma_3'$, ... etc., and correlations r_1, r_2, r_3, ... etc., and M, M' be the means of the whole community, Σ, Σ' the standard deviations and R the correlation, then

$$R\Sigma\Sigma' N = S(n\sigma\sigma' r) + S\{n(m - M)(m' - M')\} \quad\text{..................(i)}$$

where S denotes summation with regard to all i groups.

In the case of the symmetrical table clearly the following relations will hold.

$$N = 2n,$$
$$M = M',$$
$$\Sigma = \Sigma',$$
$$i = 2.$$

Equation (i) will then become

$$R\Sigma^2 N = 2n\sigma\sigma' r + 2n(m - M)(m' - M),$$

whence, dividing by $2n$ we get

$$R\Sigma^2 = \sigma\sigma' r + (m - M)(m' - M).$$

But since
$$M = \frac{m + m'}{2}$$

we have
$$R\Sigma^2 = \sigma\sigma' r - \frac{(m - m')^2}{4} \quad\text{..................................(ii).}$$

On p. 278 of Pearson's memoir above referred to the values of Σ^2 and Σ'^2 are given as follows:

$$\Sigma^2 = \frac{S(n\sigma^2)}{N} + \frac{S\{n_p n_q (m_p - m_q)^2\}}{N^2},$$

$$\Sigma'^2 = \frac{S(n\sigma'^2)}{N} + \frac{S\{n_p n_q (m_p' - m_q')^2\}}{N^2}.$$

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* The reason for using such symmetrical tables was first pointed out by Pearson, *Phil. Trans.* Vol. 197 A, p. 293.

† *Phil. Trans.* Vol. 192 A, p. 277.

In the present case we shall have

$$\Sigma'^2 = \frac{\sigma^2 + \sigma'^2}{2} + \tfrac{1}{4}(m - m')^2.$$

Whence substituting in (ii) we have finally

$$R = \frac{\sigma\sigma' r - \frac{1}{4}(m - m')^2}{\frac{1}{2}(\sigma^2 + \sigma'^2) + \frac{1}{4}(m - m')^2} \quad \text{.........................(iii)},$$

which is the desired result.

In order to save space I have given in the Appendix, in those cases where we have both symmetrical and unsymmetrical tables for a given pair of characters, only the symmetrical tables in all but a few instances where the others are introduced for a special purpose.

We may now turn to the results. In Table XIV. are given the coefficients of correlation for what we may call "direct assortative pairing," namely for those cases in which the given character—either length, breadth, or index—in one individual is correlated with the same character in the other individual of the pair.

TABLE XIV.

Direct Assortative Pairing in the Conjugation of Paramecium.

Series	Characters		Coefficient of Correlation from symmetrical tables	Tables	Coefficient of Correlation from tables in which each pair is entered but once	No. of pairs
A	Length of *A*	Length of *B*	·5327 ± ·0333	*A* 3 and 4	·5365 ± ·0469	105
,,	Breadth of *A*	Breadth of *B*	·2176 ± ·0443	*A* 5 ,, 6	·2956 ± ·0601	105
,,	Index of *A*	Index of *B*	·3487 ± ·0409	*A* 7 ,, 8	·4017 ± ·0552	105
C	Length of *A*	Length of *B*	·7249 ± ·0225	*C* 3 ,, 4	·7250 ± ·0318	101
,,	Breadth of *A*	Breadth of *B*	·3417 ± ·0419	*C* 5 ,, 6	·3492 ± ·0589	101
,,	Index of *A*	Index of *B*	·5095 ± ·0351	*C* 7 ,, 8	·5157 ± ·0493	101
D	Length of *A*	Length of *B*	·4302 ± ·0972	*D* 1	·4355 ± ·1366	16
B	,, *A*	,, *B*	·7941 ± ·0509	*B* 1	·9106 ± ·0333	12
AA	,, *A*	,, *B*	·5882 ± ·0221	*AA* 3	·5893 ± ·0311	200
,,	Breadth of *A*	Breadth of *B*	·3490 ± ·0296	*AA* 4	·3533 ± ·0417	200

I think it will be granted by all that these results are remarkable. When we remember that the highest values which have been so far obtained for the coefficients measuring assortative mating in man do not exceed ·3, these very high values for Paramecium seem at first sight astonishing or even incredible. In only one case out of five does the coefficient for the lengths give a value lower than ·5, and this is in the case of a very small series in which the probable error of the determination is about ± ·1. It should perhaps be stated again that these coefficients represent the actual conditions found by making careful measurements on pairs of conjugants taken entirely at random from three different cultures at different times. There can be no doubt, I think, of the *existence* of a high degree of correlation between the same characters in the two members of pairs of conjugating Paramecia as they occur under normal cultural conditions. But although these results demonstrate the existence of a high correlation, they thereby immediately direct attention to the very interesting and important question as to what its origin and meaning may be. The purpose of the further analysis is to throw light, if possible, on these problems.

The first point needing consideration is the character of the regression for these direct correlations. In order to show this, I have prepared diagrams giving the means of the arrays and the fitted regression lines, for the three direct correlations of Series *A*. Diagram VI. gives the regression of the length of *B* on the length of *A*; Diagram VII. the regression of breadth of *B* on breadth of *A*; and Diagram VIII. the regression of index of *A* on index of *B*.

There can be no doubt of the essential linearity of the regressions. The diagrams show very clearly the regularity with which an increase in the size of one member of the conjugant pair is accompanied by a proportional increase in the other member.

The cross correlations may now be examined. Neglecting the indices, which it hardly seems worth while to consider separately in the cross correlations we have for each group two possible cross correlations, viz., length of *A* with breadth of *B*, and length of *B* with breadth of *A*. Cross correlations for the short series

Series *A*.

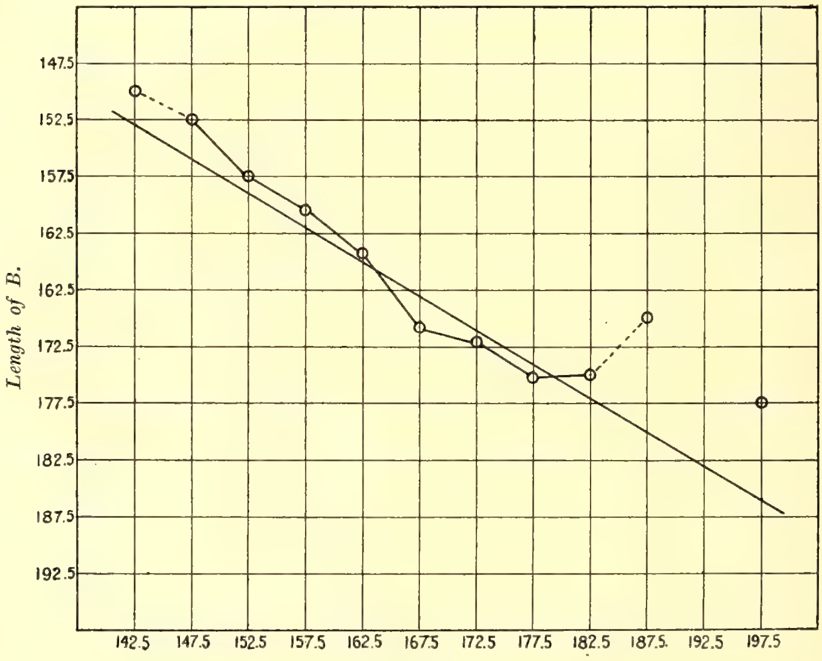

DIAGRAM VI. Regression line for the homogamic correlation between the lengths of the individuals of conjugant pairs in Series *A*. (See footnote, p. 241.)

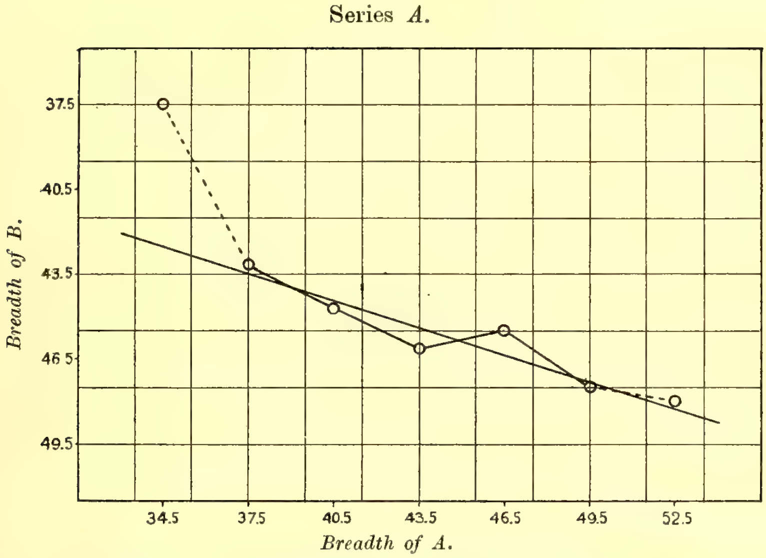

DIAGRAM VII. Regression line for the homogamic correlation between the breadths of the individuals of conjugant pairs in Series A.

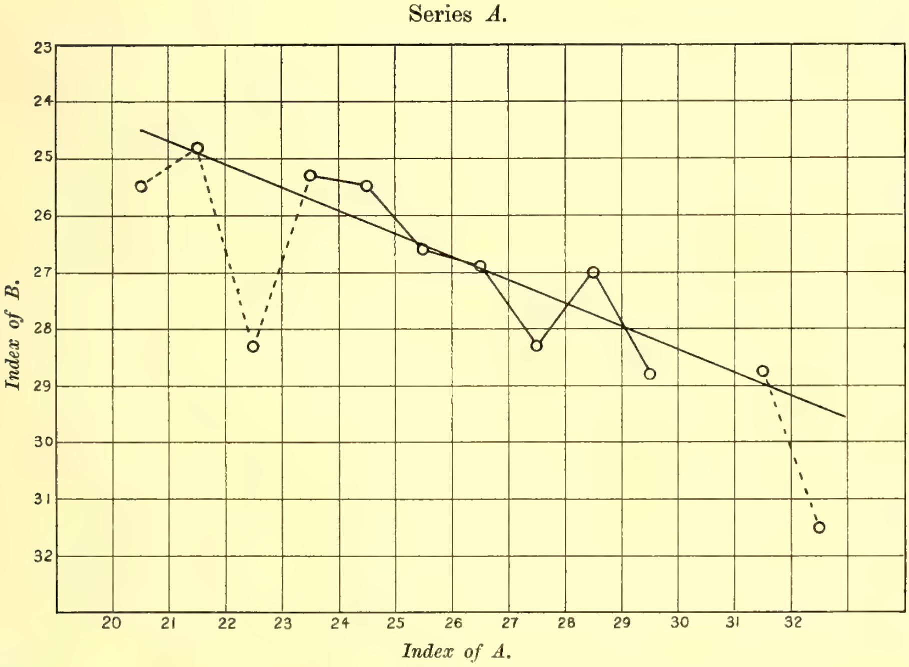

DIAGRAM VIII. Regression line for the homogamic correlation between the indices of the individuals of conjugant pairs in Series A.

B and *D* have not been determined. For the other series the coefficients are shown in Table XV.

TABLE XV.

Coefficients of Cross Assortative Pairing in the Conjugation of Paramecium.

Series	Characters		Coefficient of Correlation	No. of pairs	Table
A	Length of *A*	Breadth of *B*	−·0360 ± ·0657	105	*A* 9
"	" *B*	" *A*	·0969 ± ·0652	105	*A* 10
C	" *A*	" *B*	·0789 ± ·0667	101	*C* 9
"	" *B*	" *A*	·1150 ± ·0655	101	*C* 10
AA	" *A*	" *B*	·1740 ± ·0463	200	*AA* 5
"	" *B*	" *A*	·1482 ± ·0466	200	*AA* 6
	Mean		·1082*		

We see that these cross coefficients are, with a single exception, positive, but they are all very low. In Series *AA* alone are the values significant when compared with their probable errors. The higher values for the cross correlations in this series are due, without much doubt, to the higher direct correlation for the breadths, and the relatively high organic correlation between length and breadth which we have found in this series. The relation of the cross coefficients to the direct and organic correlation coefficients will be taken up later.

With the coefficients of assortative pairing, both direct and cross, for the actually occurring conjugant pairs in hand we may attack directly the problem of the origin of the high direct correlations. The first question which arises is as to whether these correlations represent any true assortative pairing or merely arise because conjugation goes on within a limited, differentiated portion of the population, which portion, as has been shown above, is much less variable than the non-conjugant population. If the latter is the true explanation then clearly any random pairing of conjugants ought to give rise to coefficients of correlation equally high within the limits of the probable errors concerned. What then must be done is to make from the records pairs of conjugants chosen entirely at random, and then determine the degree of correlation for such pairs. This "random pairing" has been carried out in the case of the conjugants in the following way. Each individual conjugant's measurements were copied on to a small card or ticket, then these cards were shuffled together in a convenient receptacle, and drawn out blindly, two cards at a time. The two cards so drawn formed a "random" pair of conjugants, and by entering each such pair twice (*vide supra* p. 249) the symmetrical random tables were formed. For each series and pair of characters a number of these random tables were made. The length-length random correlations are the only ones which it is necessary to discuss here. Others have been made but give the same results. Also, though usually more than one coefficient of correlation for random pairing will be given it has not been thought necessary to publish but one random correlation table for each series. We have then in Table XVI. the coefficients measuring the correlation between the lengths of the two members of random pairs of conjugants. It will be understood that when two values are given for a single series, these values represent different trials. No two random tables on the same material will, of course, give *identical* results. I have tried to give examples of the better and worse results which one gets.

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* This is the mean numerical value, without regard to the sign of the coefficients.

TABLE XVI.

Length-Length Correlation in Random Pairs of Conjugant Paramecia.

Series	Characters		Coefficient of Correlation	Table
A	Length of *X*	Length of *Y*	– ·0847 ± ·0462	—
A	„ *X*	„ *Y*	– ·1075 ± ·0460	*A* 11
C	„ *X*	„ *Y*	·0449 ± ·0474	*C* 11
AA	„ *X*	„ *Y*	·0345 ± ·0337	—
„	„ *X*	„ *Y*	– ·0360 ± ·0337	—

It is at once evident that actual conjugation and random pairing of conjugants are quite different things. No one of these random values can be regarded as significantly different from zero, whereas for the same characters and the same individuals paired together as they are in actual conjugation, the coefficients are > ·5. The results given for Series *A* are the most divergent from zero of any of the lot, and in the second of these trials we have a result which may just possibly be significant in comparison with its probable error, but certainly the others are not. We do not even find agreement as to the sign of the random correlation. It would seem that some other factor besides mere random pairing among the conjugants is necessary to produce the high degree of correlation which we find in conjugation.

To test this matter still further I made random pairings in the same way for (*a*) non-conjugants and (*b*) pairs, one member of which was a conjugant and the other a non-conjugant, and also (*c*) I considered as a pair the two non-conjugants which happened to lie in the field of the microscope nearest to each pair of conjugants measured.

These pairings were made to meet special objections which might be raised against considering what we are dealing with here as real homogamy. First it might be said that the observed correlations were in some way due to the fact that conjugants are differentiated from non-conjugants, and that random pairs of non-conjugants might show a spurious homogamic correlation. Random pairings (*a*) and (*b*) should test any such hypothesis as this. Again it might be maintained that since at different points in the culture and at different times the environment no doubt differs slightly, there would be a corresponding local differentiation of the Paramecia in each local culture unit. Then, even though the pairing were quite at random in each locality, yet if the records for several such localities were mixed a spurious homogamic correlation would arise. Now the samples used in this work were taken in just such a way as would make most pronounced any spurious correlation due to local differentiation resulting from place or time factors. Small samples—a drop or two of culture fluid—were taken from different parts of the culture at intervals of time. But it is clear that if the observed homogamic correlation were spurious and due to this "local differentiation" factor, we ought to get sensibly as high values if we consider as a pair the two individuals lying nearest in the field of view to each pair of conjugants measured. Such pairs will have come from the same environment and have been killed at the same instant as the actually conjugated pairs. If such random pairs show no homogamic correlation, then it seems to me that it will have been demonstrated that the observed homogamy is not a spurious correlation due to local differentiation in the culture.

The results of these experimental random pairings are shown in Table XVII.

TABLE XVII.

Length-Length Correlation in Random Pairs of Non-Conjugant Paramecia.

Series	Characters		r	No. of pairs
A	Length (Non-Conjugants)	Length (Non-Conjugants)	$-·0894 \pm ·0462$	105
"	" " "	" "	$·1204 \pm ·0459$	105
"	" (nearest individuals to Conjugants)	" "	$·0908 \pm ·0462$	105
"	" (Non-Conjugants)...	" (Conjugants ...	$-·0167 \pm ·0465$	210
"	" " "	" "	$·0407 \pm ·0464$	210
C	" " "	" (Non-Conjugants)	$-·0575 \pm ·0473$	101
"	" (nearest individuals to Conjugants)	" "	$·1190 \pm ·0468$	101
"	" (Non-Conjugants)...	" (Conjugants) ...	$-·0256 \pm ·0474$	202

Here again we reach the same result as before, that random pairings, however made, among the individuals living in the same culture at the time of a conjugation epidemic give rise to correlations between the members of the pair sensibly equal to zero. In Table XVII., four out of the eight coefficients are plus and four minus, and none is significant in comparison with its probable error. These are just the results to be expected if the true value of the coefficient of correlation for random pairing is zero and we take a number of random samples to determine it. We must conclude, I think, that the high coefficient of assortative pairing observed in the actually conjugated pairs cannot be accounted for by any general assumption that there is so little variation in the conjugant population that random pairing will produce high correlation. Random pairing in the identical populations in which we find high homogamic coefficients actually gives rise to zero coefficients. Nor can it be said that the observed homogamy is due to the fact that small samples were taken at different times from different parts of the culture, and that consequently we are dealing with a spurious correlation which appears because of local differentiation within the culture. If the two individuals lying nearest in the field of view to each conjugant pair measured be taken as a pair and a correlation table formed for such pairs, the coefficient for the homogamic correlation is sensibly zero. Yet such pairs came at the same instant from the same environment that the conjugated pairs did. Therefore the observed correlations for conjugated pairs cannot be due to these factors.

We may now proceed to look at this fact of a high degree of homogamy in conjugant pairs in another way. To say that there is a high degree of homogamy

TABLE XVIII.

Frequency Distributions of the Difference in Length between the Members of (a) Observed Conjugant Pairs, and (b) Random Pairs of Non-Conjugants.

Difference in microns	Conjugant Pairs				Random Pairs of Non-Conjugants		
	Frequency				Difference in microns	Frequency	
	Series *A*		Series *C*			Series *A*	Series *C*
	Conjugated	Random	Conjugated	Random			
0— 1·9	11	10	12	4	*0— 3·9*	9	12
2— 3·9	19	4	22	8	*4— 7·9*	16	12
4— 5·9	14	11	17	12	*8—11·9*	15	13
6— 7·9	16	9	13	12	*12—15·9*	14	6
8— 9·9	6	6	11	4	*16—19·9*	11	11
10—11·9	10	9	5	8	*20—23·9*	13	6
12—13·9	5	6	5	5	*24—27·9*	10	12
14—15·9	4	10	4	4	*28—31·9*	7	7
16—17·9	7	8	3	3	*32—35·9*	2	3
18—19·9	4	6	2	9	*36—39·9*	3	4
20—21·9	6	5	2	4	*40—43·9*	0	8
22—23·9	1	6	1	7	*44—47·9*	3	3
24—25·9	1	5	2	3	*48—51·9*	0	1
26—27·9	0	0	1	2	*52—55·9*	1	0
28—29·9	0	2	0	3	*56—59·9*	0	2
30—31·9	1	0	0	6	*60—63·9*	1	0
32—33·9	—	1	0	1	*64—67·9*	—	1
34—35·9	—	4	0	1	—	—	—
36—37·9	—	1	1	0	—	—	—
38—39·9	—	2	—	0	—	—	—
40—41·9	—	—	—	1	—	—	—
42—43·9	—	—	—	1	—	—	—
44—45·9	—	—	—	2	—	—	—
46—47·9	—	—	—	0	—	—	—
48—49·9	—	—	—	0	—	—	—
50—51·9	—	—	—	1	—	—	—
Totals	105	105	101	101	—	105	101

in conjugant pairs means that the differences between corresponding characters in the two members of such pairs must be relatively small. It will be of interest to examine the difference distributions for the character length in actually conjugated pairs, and in random pairs of non-conjugants and conjugants. The difference distributions which follow were made by finding the absolute difference (in microns) between the lengths of the two members of a pair, taking the differences as always positive, and forming distributions of their frequencies. The unit of grouping adopted was in the case of the conjugated pairs and random pairs of conjugants 2 microns, and in the case of the random pairs of non-conjugants, 4 microns. These difference distributions are shown in Table XVIII.

It is at once evident from these frequency distributions that the differences in length between the members of pairs are absolutely very much less in the case of the conjugated pairs than in random pairs of either conjugants or non-conjugants, and also they show less "scatter" about the mean. The great divergence between conjugated and random pairs will perhaps not at first sight be evident to one unaccustomed to working with frequency distributions, because of the difference of the units of grouping used. If we plot these distributions, however, as has been done for Series *C* in Diagram IX., in such a way that the areas and base units of conjugant and non-conjugant polygons are the same, the facts are at once obvious.

It is seen that in over 60 per cent. of the conjugated pairs the two members differ in length by less than 8 microns, while in more than 60 per cent. of the random pairs of conjugants, and in more than 75 per cent. of the random pairs of non-conjugants the difference is 8 microns or more. A more precise comparison of the groups may be made from the constants of the frequency distributions which are exhibited in Table XIX.

TABLE XIX.

Variation Constants for Difference Distributions.

Series and Groups	Mean	Standard Deviation*	Coefficient of Variation
Series *A*. Conjugated Pairs ...	8·943 ± ·435	6·610 ± ·308	73·914 ± 4·978
„ *A*. Conjugants (Random) ...	14·143 ± ·631	9·593 ± ·446	67·830 ± 4·376
„ *A*. Non-Conjugants (Random)	17·619 ± ·785	11·924 ± ·555	67·676 ± 4·359
„ *C*. Conjugated Pairs ...	7·931 ± ·448	6·681 ± ·317	84·245 ± 6·219
„ *C*. Conjugants (Random) ...	15·673 ± ·758	11·297 ± ·536	72·079 ± 4·885
„ *C*. Non-Conjugants (Random)	21·010 ± 1·003	14·939 ± ·709	71·105 ± 4·785

We see that the mean difference in the case of the random pairs is very much greater than in the case of the conjugated pairs. Also the random pairs give a much higher absolute variability. The coefficients of variation are large because

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* In calculating the standard deviations for the distributions, Sheppard's correction was not used, because we have no approach to high contact at the lower end of the range.

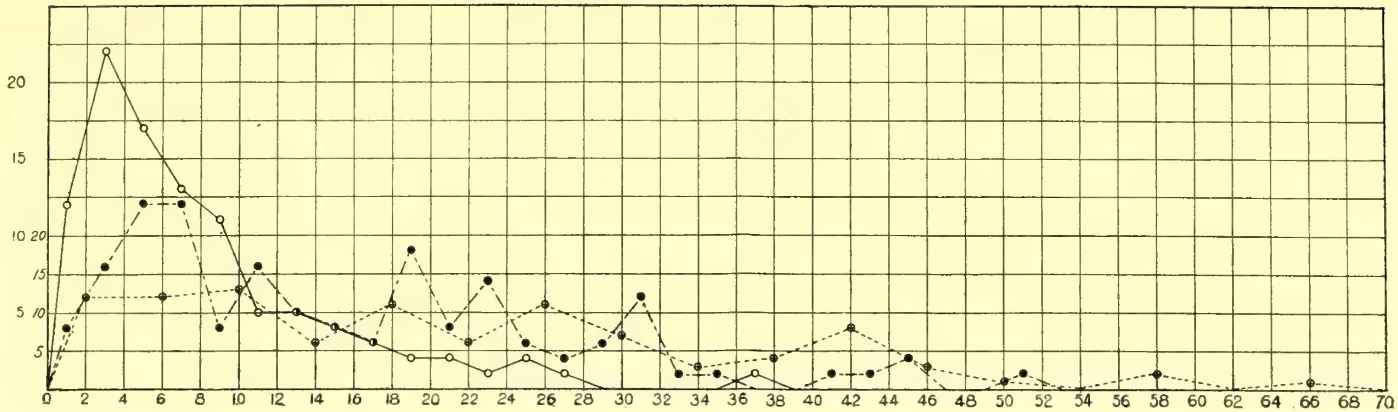

DIAGRAM IX. Frequency polygons for variation in the difference between the lengths of the individuals of conjugated and random pairs in Series *C*. The unit of abscissa is 2 microns. The scale of ordinates is so taken as to make the areas equal. —o—, Conjugated pairs. ---⊕---, Random pairs of non-conjugants. ---●---, Random pairs of conjugants.

the absolute values of the means are low. From these it would appear that, in proportion to its size, the difference is sensibly equally variable in the conjugant and in the random pairs. It is perhaps doubtful, however, whether any significance should be attached to the coefficient of variation in this case, considering the character we are dealing with. I think it is quite clear that in comparing the conjugated pairs and random pairs of conjugants with respect to the variability of the difference, we should use the standard deviation as the measure, since we are dealing with identically the same individuals in the two cases. The noteworthy thing in this case is that random pairings, whether of conjugants or non-conjugants, give higher mean differences between the members of the pair, and these differences more widely scattered about their mean value, than do normal actually conjugated pairs.

The results of this section may be summarized as follows: *In a series of samples taken from different cultures and from the same culture at different times in the history of a conjugation epidemic, it has been found that there exists a high degree of correlation between the lengths of the two members of conjugating pairs. There is a sensible, though not a high, degree of correlation between the members of conjugant pairs with respect to the other characters studied, viz., breadth and index. These high homogamic correlations have been shown to be due to something other than random pairing in a homogeneous population of low variability. An examination of the distribution of the differences in length between the members of conjugant pairs has shown that, as would be expected, the mean difference is much lower and there is less "scatter" about the mean in the case of the conjugating pairs, as compared with random pairings of either conjugants or non-conjugants.*

VII. *Discussion and Interpretation of Results.*

All discussion of results, either in the way of accounting for the phenomena or pointing out their significance, has been deferred to this point for the reason that with all the data in hand the relationship of the different sets of facts to each other comes out more clearly.

We may consider first the fact that the conjugant population is differentiated from the general non-conjugant population in the same culture at the same time. Maupas* maintained that there were several morphological stigmata by which Infusoria in the depressed condition preceding conjugation were marked. One of these morphological characteristics was reduced size. That pre-conjugants are smaller in size than ordinary individuals has been noted by a number of other workers. Thus, for example, Gruber† says that "meist kleinere durch rasch aufeinander folgende Theilungen enstandene Individuen sich conjugiren," though he proceeds in the next sentence to point out what is quite true, that it is "nicht

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* *Arch. d. zool. exper. et gener.* (2) t. VI. pp. 165—277 and *Ibid.* t. VII. pp. 149—517.

† *Bericht der Naturf. Ges., zu Freiburg. i/B.* Bd. II. p. 51.

immer die kleinsten Individuen welche conjugiren." Hertwig* found the same thing in his cultures, namely that conjugants were below average size†.

While there would appear then to be general agreement that the conjugating individuals are usually smaller in size than the average for the general population of non-conjugants, it has not hitherto been noted, so far as I know, that conjugants are also differentiated from the general population in variability and correlation. This is of course only natural since nothing but measurements of considerable numbers of individuals will give an appreciation of variation and correlation in size dimensions in so small an organism as Paramecium. The fact that conjugant individuals are markedly differentiated in variability from the general population if generally true is unquestionably of considerable importance in connection with the whole problem of reproduction and variation in the Infusoria, however the differentiation may be produced. The decrease in size preceding conjugation has usually been explained as due to a brief period at this time of unusually rapid division in which there is little time for growth between succeeding fissions. Calkins‡ has shown however that this period of rapid division does not always precede conjugation. Consequently the reduced size must, in some cases at least, be due to some other factor. In his most recent paper on the subject, this investigator§ has brought out some very interesting facts regarding the protoplasmic condition of Paramecium in periods of depression, showing that with the reduced size usually observed at such times there are associated characteristic changes in cytoplasmic and nuclear structures. His results, for the details of which the original paper must be consulted, certainly point to the conclusion that the reduction of size (and also probably the changes in variabilities and correlations) observed in conjugants depend upon fundamental and deep-seated changes in the physiological condition of the organism connected with reproduction. It seems to me that this conclusion is much more probable than that we have to do with any direct selection in the ordinary sense. It is quite clear that there is no immediate elimination of those members of the culture which do not conform to the conjugant type. The possibilities in the way of change of variability in Paramecium without selection, but instead as a result of a direct general bodily rearrangement, or "Umwandlung," are known to be great||, and it seems to me altogether likely that in the differentiation of conjugants from non-conjugants we are dealing with a case of this kind.

There is a point which might be raised in objection to the view that the differentiation of the conjugant population is to be thrown back on deep-seated physiological causes. It might conceivably be maintained that the reduced variability of conjugants which has been found is a result of the conjugation process

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[*] *Abhandl. der k. bayer. Akad. der Wissensch.* II. Cl. Bd. XVII. pp. 153—233.

[†] *Note added Nov.* 10. Mr Lister (*loc. cit.*) accuses me of being ignorant of the literature on this point. I leave it to the reader to judge what foundation exists for this accusation. R. P.

[‡] *Loc. cit.* p. 158.

[§] Calkins, G. M.: *Journ. of Exper. Zool.* Vol. I. pp. 423—461.

[||] Cf. Pearl, R., and Dunbar, F. J.: *Seventh Report, Michigan Academy of Science*, pp. 77—86.

itself, and not a really significant thing at all. Our data for conjugants are obtained from conjugated pairs, and it might be maintained that the pro-conjugants were simply a random sample from the general population having equal variability with it. Then if we supposed that during the conjugation act itself there was a pronounced tendency towards equalization in size of the two members of a conjugant pair, we might get a reduction in the variability of conjugated individuals as a result of the act of conjugation while the pro-conjugants were not less variable than the general population. Now data were especially collected to determine whether any such process of equalization occurred during the act of conjugation, and anticipating results to be presented in detail farther on, it may be said that the most careful search has failed to find any evidence supporting this view. One has been compelled to conclude that such a process of equalization in size during conjugation does not occur to any appreciable degree. That there is absolutely no tendency to equalization cannot of course be said but, so far as the available data indicate, if any such tendency does exist it is far too slight in amount to account for the changes in variability and correlation observed. Furthermore, such a tendency to equalization would not help us at all in explaining the reduced mean size of conjugants, and it seems altogether probable that the same set of causes are responsible for the changes in means and variabilities.

The first problem with which this paper has to do was stated at the beginning (p. 215) to be "Is the portion of the Paramecium population which is in a state of conjugation at a given time differentiated in respect of type or variability, or both from the non-conjugating portion of the population living in the same culture at the same time?" *So far as our present material goes the answer to this question is unequivocally that there is such a differentiation in both type and variability. The morphological differentiation of conjugants is held to be probably due to fundamental physiological changes which precede and lead to conjugation.* The further question as to the cause of these physiological changes falls outside the scope of the present investigation. It is a subject on which there is urgent need for experimental work.

We may turn now to the question of homogamy in the conjugation of Paramecium. We have seen that when measurements are taken on the individuals of conjugated pairs, there is found to be a high degree of direct homogamic correlation. Our problem is to find, if possible, a reasonable explanation for the existence of this correlation. It is evident that there are at least two possibilities here which suggest themselves immediately. One is that there is no real pairing of like with like, but that after two individuals have become definitely united in a syzygy, an exchange of substance takes place until there is what we might call an equilibrium of internal pressures. In this process it might be conceived to result that the smaller individual of the pair becomes larger and the larger smaller, so that at the end both would be more nearly alike in size than they were at the beginning. If then we measured the coefficient of homogamic correlation after this had occurred, it might be found high without any real selection having taken place in the pairing. The homogamy would be altogether physical instead of biological. The alternative hypothesis to that just outlined is that there is a real pairing of like with like, brought about in some way by non-conscious means.

In considering these two alternatives, it seemed to me that the first was rather improbable on general grounds. In the first place no biological evidence has been presented, so far as I know, to show that in the conjugation of Paramecium any such extensive interchange of endoplasm as would be demanded by this view occurs very early in the conjugation process. In this connection it should be pointed out that if we are to explain the degree of homogamy observed by any process of equalization, it will be necessary that the equalizing occur early in the conjugation, as otherwise it will not help us at all. The reason for this is clear. If random samples are taken from a conjugating population we shall get, on the average, just as many early as late stages of the conjugation process. Therefore if equalization between members of the pair does not occur till a late stage, obviously it will have affected but a small portion of the conjugant pairs in any random sample. So then we would not find a high degree of homogamic correlation in such a sample. But, as a matter of fact, we do; hence it is to be concluded, I think, that if any equalization occurs at all, it must occur very early in the process. But observation gives no indication that such an equalization takes place immediately after the union of the individuals. I have been unable to find the slightest evidence that any exchange of material between the two conjugants occurs prior to the exchange of the portions of the micronuclei which, of course, is relatively late in the conjugation process.

Again, on purely physical grounds, it seems to me by no means certain that the equalization hypothesis is adequate. Suppose we consider a Paramecium to be a bag of fluid (the endoplasm) surrounded by an elastic membrane (the ectoplasm and pellicle) in a state of tension. Then it would be expected, according to the laws of curved elastic membranes generally, that if two such bags were connected so that interchange of the contained fluid was possible, it would be pressed from the smaller into the larger, because the larger has the greater radius of curvature and hence less internal pressure assuming that the average state of surface tension is the same for large and small individuals. But this is of course the opposite of what the equalization hypothesis demands. It would seem likely that if an equalization between the two individuals of a conjugant pair occurred, it would have to be accounted for on biological, rather than purely physical grounds.

There is still another consideration which militates against the equalization hypothesis. If the apparent assortative mating arises through any such process, it is difficult to see why the direct homogamic correlation between breadths should not be of about the same degree as that between the lengths. In fact it would seem likely considering the form of the organism that any process of exchange of substance would more nearly equalize the breadths than the lengths of the two individuals of the pair. Thus the breadths would be correlated at least as closely as the lengths. But as a matter of fact, as we have seen, there is no approach to equality between the direct homogamic correlations for length and breadth. Those for breadth are always lower.

In order to make, so far as possible, a decisive test of whether the observed homogamic correlation is due to an equalization in size of the two members of the pair during the process of conjugation itself or is, on the other hand, a result of some process such that it exists at the moment of pairing, an investigation based on the following considerations was carried out.

If the observed homogamic correlation is due to any process of equalization in size during the act of conjugation itself, then clearly we should expect to find a higher degree of correlation between the members of pairs in late stages where the individuals would shortly separate than in early stages where the union had just been accomplished. To test this question, 70 pairs of conjugants in very early stages and 77 pairs in late stages were measured. The basis of the separation into "early" and "late" stages was the nuclear condition. The limits chosen as well as other data regarding these two series—designated respectively as "Series F, Early" and "Series F, Late"—have been given in detail earlier in the paper (p. 221) and need not be repeated here. The important thing to keep in mind is that, taken as a whole, the individuals of the F_E series were recently joined pairs, and those of the F_L series were on the whole nearly at the end of the process and would soon have separated. In Table XX. the constants of these two series are compared*. The differences are taken as positive when the "late" series is in excess of the "early," and negative when the opposite condition obtains.

We see at once that the "late" series does not significantly differ from the "early" in anything but the means, and there the difference is only barely significant. Both series are equally variable, and show equally high homogamic correlation. Instead of the "late" series giving the higher values for this correlation, as we should expect on the equalization hypothesis, the "early" series actually has slightly the higher coefficients! The differences are of course not significant in comparison with the probable errors. In fact no closer equality between two random samples of the same population could be desired. The results show that in these samples at least there was no significant change in the size relations of the body associated with the nuclear changes of the conjugation process during that portion of it studied. If any equalization in size between the two individuals occurred, it must have taken place very shortly after the union, and have been a very brief process. Both of these things seem improbable on biological grounds.

In order to get further evidence on the matter some direct observations on the living organism were made, though on account of lack of sufficiently abundant

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* It should be stated that the fundamental tables for the F series are grouped in units of the ocular micrometer. The constants deduced were multiplied by 8·6, the value of a micrometer unit in microns, to obtain the means and standard deviations tabled.

TABLE XX.

Variation and Homogamy in Early and Late Stages of the Conjugation Process.

Character	Constant	Series *F*, Early	Series *F*, Late	Difference	Tables
Length of All Conjugants	Mean	208·489 ± ·983	214·051 ± ·966	+5·562 ±1·379	*F* 2 & *F* 4
" " "	S. D.	17·247 ± ·695	17·774 ± ·683	+ ·527 ± ·975	" "
" " "	C. V.	8·272 ± ·336	8·304 ± ·321	+ ·032 ± ·465	" "
Length of *A*	Mean	209·103 ±1·432	214·497 ±1·378	+5·394 ±1·987	*F* 1 & *F* 3
" "	S. D.	17·767 ±1·013	17·927 ± ·974	+ ·160 ±1·405	" "
" "	C. V.	8·497 ± ·488	8·357 ± ·458	− ·140 ± ·669	" "
Length of *B*	Mean	207·874 ±1·345	213·604 ±1·353	+5·730 ±1·908	*F* 1 & *F* 3
" "	S. D.	16·689 ± ·951	17·609 ± ·957	+ ·920 ±1·349	" "
" "	C. V.	8·028 ± ·461	8·244 ± ·451	+ ·216 ± ·645	" "
Difference between *A* and *B* in Length * ...	Mean	11·794	12·286	+ ·482	
Correlation between *A* and *B* in Length	*r* †	·6797 ± ·0307	·6212 ± ·0334	− ·0585 ± ·0454	*F* 2 & *F* 4
	r ‡	·6832 ± ·0430	·6223 ± ·0471	− ·0609 ± ·0638	*F* 1 & *F* 3
Number of Pairs ...		70	77		

material it was not possible to do much in this direction. The results so far as they went were in entire accord with what was found from the statistics. I was unable to detect any change whatever in the relative lengths of the two members of the pair after conjugation had occurred.

Altogether, taking into account the results from the *F* series and from direct observations, together with the fact that we get closely accordant results for the homogamic correlations in all our series, though the Ann Arbor series were collected in a quite different manner from the Leipzig series, I think we must conclude that there is no evidence to support the view that these correlations arise because of any equalization in size during the conjugation itself. It is on the other hand quite clear, of course, that the evidence here presented does not demonstrate that equalization does not occur immediately after union is effected. I can think of but one way in which to get absolutely conclusive evidence on this point, and that is to isolate, kill and measure pairs immediately after definite union has occurred. If the homogamic correlation in a reasonably large sample of this kind is no different from that of conjugants in general, it will be demonstrated that homogamy is not due to equalization after union.

* Without reference to whether *A* or *B* is the larger.

† Coefficient from symmetrical table in which each pair is entered twice. See p. 249.

‡ Coefficient from table in which each pair is entered but once.

We may now consider the second alternative, namely that the homogamic correlation is real and arises at the moment the definitive pairing occurs. The only difficulty with this alternative is that of understanding how any real assortative pairing can take place in such a low organism as Paramecium. This difficulty however is more apparent than real, I believe. Let us consider some of the known facts regarding the behaviour preceding conjugation*.

The points which are especially important for our present purpose are as follows. (1) It is well known that a modification of the body substance occurs, resulting in the organisms becoming adhesive on their oral surfaces (cf. Calkins, *loc. cit.*, and Jennings†). They are then in what Calkins calls the miscible state. At such times, as has been noted by different observers‡, groups of several individuals may be formed and subsequently separated again. Single pairs by no means always remain united after they have once come together. Thus Jennings says: "Specimens......become adherent in every possible way provided merely that some part of the oral surface of one of the individuals enters into the adhesion. Many such cases are clearly not early stages of any ordered conjugation, and they often separate after one individual has been dragged about for some time much against his struggles."

(2) I have been able to observe in a few instances that the firm union of the two individuals in a definite ordered conjugation involves at the beginning only the extreme anterior ends. Next the mouth regions unite firmly, and somewhat later the portions of the body between the two points. I have not infrequently found pairs in which firm union had occurred at the anterior ends and the mouth regions, and in which there was no contact between the individuals in the intermediate region of the bodies. These observations confirm what has been found by Gruber§. He says, "Die Vereinigung geschieht zunächst vorne an der Spitze der beiden Infusorien und dann an den Mundöffnungen also näher den Hintergrunde. An diesen beiden Stellen bleiben die Thiere festvereinigt, während der übrige Theil des Körpers nur lose oder gar nicht mit dem des anderen Individuums vereinigt ist."

(3) The coming together of a particular pair of individuals in the proper position for effective conjugation is without any doubt, I think, a matter of random chance. What is in all likelikood the true explanation of this has been given by Jennings‖ in the following words: "A second important factor¶ in bringing

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* It is a matter of deep regret to me that I have been able to make so few observations myself regarding the behaviour at the time of conjugation, but I have not yet been fortunate enough to obtain a culture in which a conjugation epidemic involving large numbers of the population was taking place. For observations of this kind on behaviour one must have large numbers of individuals. In what follows then I shall have to make use largely of the observations of other workers, though in no case is a statement made which has not been confirmed, either by my own observations, or by at least two independent investigators.

† Jennings, H. S.: *Jour. Comp. Neurol. and Psychol.* Vol. xiv. No. 6, pp. 480—482.

‡ Cf. for example Jennings, *loc. cit.* p. 481, and Gruber, *loc. cit.* p. 45.

§ Gruber, *loc. cit.* p. 46.

‖ *loc. cit.* p. 482.

¶ The first is the adhesiveness of the oral surfaces mentioned above. R. P.

about conjugation is found in the usual ciliary movements of the animals, and in the currents produced by these movements. As we have seen in the foregoing pages, there is a strong current passing backward along the oral side of Paramecium so that there is a tendency for all sorts of objects suspended in the water to be carried to the oral groove. This tendency is of course operative on other Paramecia in the neighbourhood, as well as upon lifeless objects. In the case of two Paramecia close together, this tendency is of course reciprocal; each tends to draw the other to its own oral groove. Thus if two Paramecia are swimming along close together, there is a strong tendency through their usual movements for them to come together with oral surfaces in contact. Under ordinary conditions this is often seen, but does not lead to conjugation because the oral surfaces are not adhesive. But when the oral surfaces are adhesive, as we know them to be at periods of conjugation, then the animals stick together."

Now, considering all these facts, we are able to understand I think how the observed homogamic correlation may arise. For the sake of clearness, a brief and somewhat categorical outline of the process as I conceive it to occur will be given first, and then the points which need further discussion will be taken up afterwards. (*a*) At the periods of conjugation, the individuals which are to conjugate are in a certain physiological state associated with the "miscible" condition in which the oral surfaces are adhesive. (*b*) As a result of the reciprocal action of the currents produced by the oral groove cilia, two individuals which by chance happen to be swimming parallel and close to one another are drawn together, and their oral surfaces adhere in whole or in part. (*c*) The extreme anterior ends of the oral grooves firmly adhere to one another first. (*d*) If the two individuals are so nearly the same size that the mouths approximately coincide when the anterior ends are together, firm union occurs at the mouth regions and definite conjugation follows. (*e*) If, on the other hand, the mouths do not approximately coincide the individuals separate again or die, and no conjugation results. (*f*) The homogamic correlations arise then as a result of the necessity for the mouths of the two individuals to come together (or "fit") when the extreme anterior ends are united. Individuals in which the distances from the anterior end to the mouth are approximately equal will not be greatly different in total length, and hence their lengths will be correlated.

We may now consider the evidence regarding the various points. The facts (*a*), (*b*), and (*c*) rest on direct observation. With reference to (*d*) it may be said that out of hundreds of pairs of conjugants examined none has been seen in which the mouths did not coincide. The extreme anterior ends of the individuals of conjugant pairs (points a, a' in Fig. 1) are in the great majority of pairs approximately equidistant from the mouths. In other words, if pairs of conjugants are examined with reference to the relative position of the extreme anterior ends it will be found that the end of one in most cases projects but relatively little in front of the anterior end of the other. Of course variation occurs in this as in everything else, but I think I am safe in saying that as a maximum not more than 10 per cent. of the total difference in length between the individuals of conjugant pairs is due to difference at the anterior ends. I do not present measurements in support of this statement for the simple reason that the magnification used in the measuring was not sufficiently high for the accurate determination of this "anterior end difference," so small is it in the great majority of cases. I think, however, that the statement that in definitely conjugated pairs of Paramecium the mouths and anterior ends of the two individuals approximately coincide will not be questioned by anyone who has ever examined closely large numbers of such pairs. Finally if (*d*), and the comments which have just been made regarding it be true, then (*c*) must necessarily be true, because if we observe that all successful conjugants have the mouths and anterior ends approximately coinciding, then clearly all pairs which did not fulfil these conditions when the individuals came together by chance, must have either separated or died. The probability of separation being what actually happens is strongly indicated by the observations of Gruber and Jennings cited above. Similarly (*f*) necessarily follows from (*d*), if there be positive correlation between total length and distance from anterior end to mouth, the existence of which can hardly be doubted.

All things considered, I think that, at least till further evidence is forthcoming, the conclusion is justified that the observed homogamic correlation arises as a result of the factors set forth above, (*a*) to (*e*). On this view the real essence of the matter is the necessity for anterior ends and mouths to "fit" reasonably well if conjugation is to be successful. The mechanism by which individuals which do "fit" are brought together is readily to be accounted for by well-established factors in the "action system" of the organism, and involves no assumption of consciousness or any vitalistic hypothesis.

It is the belief of the writer that a considerable degree of homogamy will probably be found to exist in the conjugation of other Protozoa than Paramecium, though of course no other form has yet been investigated in connection with this matter. An observation recorded by Calkins*, concerning the infusorian *Lionotus fasciola*, is of interest in this connection. He says that "In conjugation a large form unites with a smaller one, the mouth parts being united." Such a conjugant pair is found in his Fig. 33. It would be very interesting to study this case biometrically, in the light of the results on Paramecium. There would seem to be two possibilities in the case of Lionotus; one that there is a dimorphic condition of pro-conjugants paralleling sexual differentiation in higher forms, either with or without positive assortative pairing: the other that there is a negative assortative pairing in the conjugation. In any event the case seems well worth investigating.

According to the explanation which has been given for the origin of the homogamic correlation in Paramecium, the assorting in the pairing is held to be concerned only with the lengths of the individuals. If this explanation be true the homogamic correlation between the breadths of the two individuals of a pair and the cross assortative correlations must arise from the existence of an organic correlation between length and breadth in the individual and the direct selection of lengths. It would seem that we had here the means of making a conclusive statistical test of whether all the assorting in the conjugation is on the basis of length alone, by making use of the theorems in selection which Pearson* has given. Thus it should be possible to determine what would be the values of the correlations between the breadths, and between length and breadth after a selection of the lengths alone. Unfortunately, however, these theorems cannot be applied in the present case because of a fact which has been discussed before in the paper, namely that the breadth dimensions of the conjugants are changed as a result of the union in conjugation itself. As we have no data on the pro-conjugant population it is impossible to make accurate allowance for the effect of this flattening of the conjugants upon the variations and correlations. The whole matter has been studied carefully from the statistical standpoint, with the general result which may be stated without the publication of all the equations and figures, that if we assume the assorting in the conjugation to be on the basis of length alone we get a system of values for the direct breadth with breadth correlations and the cross correlations which are not inconsistent with the observed values, allowing for the effect of the change in breadth which occurs during the union. It may be possible later to make an accurate allowance for this disturbing factor, and then the complete evidence can be presented.

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* *Bulletin of the U. S. Fish Commission* for 1901, pp. 413—468.

Finally, in bringing the paper to a close, I wish to point out what seem to me to be some of the significant theoretical bearings of the results. These, I think, fall under two general heads; namely, first those considerations which arise from the fact that the conjugants are differentiated from the non-conjugants and secondly those considerations which are implied by the existence of a high degree of homogamy in the conjugation. These points will be discussed in the order mentioned.

The results of this work have given clear and indubitable evidence that in the different samples and different cultures the individuals which are conjugating at a given moment belong to a distinct type, clearly and markedly differentiated from the type of individuals which are not conjugating. The facts regarding the details of this differentiation have been shown *in extenso* earlier in the paper (Tables V., VI., VII., VIII., X., and XI., and Diagram 1), and I think there can be no doubt as to its existence in the mind of anyone who will take the pains to examine carefully these tables. Thus, unless the results are repudiated on the general ground that the material here used was in no way representative of Paramecia in general†, these facts mean that there is in Paramecium what may be called a *conjugant type.* Furthermore, this conjugant type is differentiated from the general population, not only in physiological but in morphological characteristics.

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* *Phil. Trans.* Vol. 200 A, pp. 1—66.

† That such a criticism cannot fairly be made is sufficiently evidenced by the fact, which every comparative table in the paper clearly shows, that there is a very good agreement between the results for different series taken from different cultures in different ways. Table II. by itself demonstrates that the material here used cannot be considered abnormal.

Now, it seems to me that the fundamentally important question is *whether this differentiated conjugant type is relatively more constant as we pass from culture to culture or race to race than is the type of the general population.* We know that under varying environmental influences the type of the general population in the case of Paramecia (and Protozoa generally) can be greatly modified, as a direct result of environmental action*. Is the conjugant type modified to as great a degree as is the type of the general population by such direct environmental influences? The question is clearly one of inter- rather than intra-racial variability, and as such requires a much larger amount of material than is now available for a conclusive answer. However, the results from the present material, as will be shown, point very definitely to the conclusion that the "conjugant type" is much less variable, that is, fluctuates less, as we pass from one environmental condition to another, than does the type of the general population. This fact will have been noticed, I think, from the tables given in Sections III., IV., and V. of the paper, but to make certain of the matter a direct consideration of the problem will be undertaken here.

In order to test the question as to whether the "conjugant" and "general population" types are equally changed with changing environmental conditions the biometrical procedure is to measure the amount of variation in the two types as we pass from one culture or sample to another. Now, in the present case, we have only four series of conjugants (A, C, D, and B) to put over against five series of non-conjugants (A, C, D, E, and B). The Ann Arbor series (AA and F) cannot fairly be included here because unfortunately no non-conjugants were measured from the cultures from which these came. With such small series as four in one case and five in another, it is quite clear that if any conclusions at all are to be drawn as to a difference between the series, the differences between the constants must be large. As a matter of fact the results of a comparison of conjugant and non-conjugant types in respect to length of body, are as follows†:

Mean of conjugant means = 172·408.
Mean of non-conjugant means = 203·177.
Standard deviation of conjugant means = 4·459.
Standard deviation of non-conjugant means = 10·513.

In other words we see that as we pass from one culture to another, and from one state of a culture to another, the non-conjugant type fluctuates more than twice as much as does the conjugant type. It might be objected that we should expect that there would be absolutely more variation in the non-conjugant type than in the conjugant, because the non-conjugant individuals are larger, but if we take the variation in proportion to the mean size of the conjugant and non-conjugant groups we obtain the same result.

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* Cf. for example, Yasuda, A.: *Jour. Coll. Sci.*, Imp. Univ. Tōkyō, Vol. XIII. pp. 101—140, and Pearl, R., and Dunbar, F. J., *loc. cit.*

† It should be stated that in calculating these inter-racial constants the different series were weighted roughly in proportion to the number of individuals included in each series. It seemed hardly fair to allow the same weight to the very short series B and D as to the longer A, C and E series. So then the series were assigned weights as follows: $A = C = 8$, $B = D = 1$, $E = 4$. As a matter of fact it makes very little difference in the final results if all the series are given equal weights.

Thus:

Coefficient of variation of conjugant means = 2·586 °/$_\circ$.
Coefficient of variation of non-conjugant means = 5·174 °/$_\circ$.

The general conclusion which we reach is that, *so far as can be judged by the data at present available, the conjugant type is relatively much more constant as we pass from culture to culture than is the non-conjugant type.* Of course our present data are much too meagre to demonstrate this conclusion. It is true for the material here studied: whether it is true generally can only be determined by further investigation; but the present results certainly give a fair degree of probability that it is generally true.

To recapitulate then the results of this investigation show that in the material studied (*a*) there is a differentiated "conjugant type" of Paramecium, and (*b*) this "conjugant type" is relatively fixed and constant under varying environmental conditions, as compared with the type of the general population in fission generations. Now I take it to be a well-established result of the work of Calkins and earlier investigators in this field that (*c*) at more or less regular intervals in the normal life history of a race of Paramecium the individuals which are to take part in the future propagation of the race not only do, but under normal conditions must pass through a period of conjugation. Otherwise the race will die out. Calkins' brilliant studies (*loc. cit.*) have shown that for a time the race may be kept going by various forms of artificial stimulation, but that in the end such stimulation fails in its purpose. *But if these three conclusions, (a), (b), and (c), are true, then it clearly means that those individuals which take part in the perpetuation of the race conform at intervals to a definite and relatively fixed morphological type.* This result I believe to be of considerable importance, for, if it be accepted, it seems to me to mean nothing less than that we must change somewhat radically our whole outlook on the relation of the Protozoa to evolution problems. It has been held as axiomatic in biology that acquired characters are inherited in the Protozoa because one cell is both soma and germ. But clearly it matters very little to the race whether acquired characters are inherited or not, if after every cycle of fission generations the organism must come back to the same type (barring any real evolutionary change which may have taken place) that it started from, or in the end die. The case then becomes not very much different from what obtains in higher organisms. In the Metazoa what is acquired by the soma in one generation is not usually, at least, passed on to the next. Real evolutionary progress depends on changes in the germ cells. But similarly, if what we have concluded for Paramecium be correct: *All real evolutionary progress in such a protozoan form must consist in definite changes in the "conjugant type."* So far as evolutionary progress is concerned the conjugant individuals in the Protozoa correspond to the germ cells of the Metazoa. Any modification which is to be of significance to the race or to the species must take place there, rather than during the cycle of divisions between conjugations.

It is somewhat remarkable that an entirely different line of evidence from that which has led to the above conclusions has led Calkins to conclude in his most recent paper on the subject* that the assumption seems to be warranted "that there is a fundamental difference in the protoplasmic elements which go to make up the body of a protozoan, one of which is to be compared with the somatic cells of metazoa, the other with the germ cells, the one connected with the vegetative functions of metabolism the other with reproduction; the one may give out and so lead to 'physiological death' (Hertwig), or it may be restimulated; the other may give out and so lead to 'germinal death' of the race."

It seems almost self-evident if Calkins' conclusion be accepted, that at the time of conjugation the protoplasmic elements which correspond to the germ cells of Metazoa and have to do with the reproductive functions are so to speak predominant. Then Calkins' conclusion becomes essentially identical with that which we have reached.

We have now to consider the significance of the fact that there exists a high degree of homogamy in the conjugation of Paramecium. One of the greatest difficulties against the acceptance of the theory of natural selection as the method of organic evolution has always been that of understanding how any incipient evolutionary change within a group of animals living together in the same environment is to be preserved if the individuals showing the divergent character can breed freely and successfully with those which do not have it. Thus Huxley†, in the chapter in the *Life and Letters of Darwin* on the "Reception of the Origin of Species," says: "In my earliest criticisms of the 'Origin' I ventured to point out that its logical foundation was insecure so long as experiments in selective breeding had not produced varieties which were more or less infertile; and that insecurity remains up to the present time." Romanes, in his paper on "Physiological Selection,"‡ states the difficulty very clearly in the following words: "...for in this particular case so formidable does the difficulty seem to me that I cannot believe that natural selection alone could produce any divergence of specific character, so long as all the individuals on an overcrowded area occupy that area together. Yet, if any of them quit that area, and so escape from the unifying influence of free intercrossing, these individuals also escape from the conditions which Mr Darwin names as those that are needed by natural selection in order to produce divergence. Therefore, it appears to me that, under the circumstances supposed, natural selection alone could not produce divergence; the most it could do would be to change the whole specific type in some one direction, and thus induce transmutation of species in a linear series, each succeeding member of which might supplant its parent form. But in order to secure *diversity, multiplication*, or *ramification* of species, it appears to me obvious that the primary condition required is that of preventing intercrossing with parent forms at the origin of each branch, whether the prevention be from the first absolute or only partial."

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* *Jour. Exper. Zool.* Vol. I. p. 455.

† *Life and Letters*, Vol. I. p. 170.

‡ *Jour. Linn. Soc. Zool.* Vol. XIX. pp. 337—411.

Now it is evident that if we find in any species a tendency for individuals like one another in one or more characters to mate together, rather than with individuals unlike themselves, we have at once a *vera causa* for the "divergence of individuals into varieties" by preventing intercrossing with parent forms. We need not even suppose that unions of unlike individuals are infertile provided the unions themselves do not occur or occur only rarely. The importance of homogamy has been so forcibly stated by Romanes* that I cannot do better than quote what he says. "To state the case in the most general terms we may say that if the other two basal principles are given in heredity and variability the whole theory of organic evolution becomes neither more nor less than a theory of homogamy—that is, a theory of the causes which lead to discriminate isolation, or the breeding of like with like to the exclusion of unlike. For the more we believe in heredity and variability as basal principles of organic evolution, the stronger must become our persuasion that discriminate breeding leads to divergence of type, while indiscriminate breeding leads to uniformity. This in fact is securely based on what we know from the experience supplied by artificial selection which consists in the intentional mating of like with like to the exclusion of unlike.... Only when assisted by some form of discriminate isolation which determines the exclusive breeding of like with like can heredity make in favour of change of type, or lead to what we understand by organic evolution."

Now, although the importance of homogamy as a factor in evolution has been recognized almost universally, yet so far as I know no one except Pearson in the work on assortative mating in man, which has already been referred to (p. 214), has hitherto attempted to find out exactly how great a tendency for like to mate with like actually exists in a given species. We have had general reasoning in the place of direct quantitative evidence. In the present case it has been shown that in what may be considered the simplest prototype of the mating of individuals, which becomes in higher forms associated with sexual differentiation, namely in the conjugation of the Protozoa, there is a relatively very high degree of homogamy. Like pairs with like to more than double as close a degree as in the case of man where conscious choice must be supposed to operate to the greatest extent. We have then clearly all the necessary factors for divergent evolution. Let any variation appear among the pro-conjugant individuals (i.e. in the "conjugant type") of a race of Paramecium, and if any one of the characters in which the variation appears is correlated (to any degree) with any character directly selected in the homogamic pairing, we shall at once get the beginning of a divergent race or variety. If the explanation which has been given here (p. 267) of the method of assorting in conjugation is the correct one, then the relative position of the mouth is *one* directly selected character. But it by no means follows that it is the only one. There may be other characters selected to just as close a degree in the conjugating. For the present it is sufficient to have shown that in a species living under natural conditions, a high degree of homogamy is not only possible, but actually exists.

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* *Darwin and After Darwin*, Vol. III. pp. 6, 7.

Finally it should be pointed out that the fact that we find such a high degree of homogamy in a protozoan form like Paramecium strongly suggests the possibility that in higher organisms there may be assortative mating of the gametes in the process of fertilization. Should such a homogamy of the gametes occur it would probably be of far greater importance than any assortative mating of somas.

VIII. *Summary of Results.*

The chief results of this study of variation and correlation in *Paramecium caudatum* in connection with the process of conjugation may be summarily stated as follows:

1. Biometrical analysis of the variation in a considerable number of individuals shows that Paramecium follows the same general laws which have been found to hold for continuous variation in higher forms. The coefficients for variation in length of Paramecium cluster very closely about a value of 8 per cent. Certain of the frequency distributions approach reasonably well to the normal or Gaussian curve, but this is by no means universally the case.

2. In following a single culture throughout the history of a conjugation epidemic, it was found that definite changes are produced in the population as a result of the action of the environment. These environmental effects, however, were more pronounced in the case of non-conjugants than in conjugants.

3. There is no evidence that conjugation tends to produce increased variability in ex-conjugants. All the evidence indicates, on the contrary, that conjugation serves to restrict the variability induced by environmental influences or, in other words, to preserve relative stability of type.

4. Conjugant Paramecia are distinctly and markedly differentiated from the non-conjugant population living in the culture at the same time, in type, variability and organic correlation in respect to all characters studied. This differentiation includes not only the absolute dimensions of the body, but also the shape, as measured by the length-breadth index. This differentiation of conjugants from non-conjugants is in no sense insignificant in amount, nor is it confined merely to the means of the different characters. On the contrary, it is large in amount, and just as significant for the variabilities and correlations as for the means.

5. There is a tendency for like to pair with like (homogamy) in respect to length of body in the conjugation of Paramecium of a closer degree than has hitherto been found for assortative mating in any organism. The homogamic

correlation between the lengths of the individuals of conjugant pairs has about the same value in all the series studied, and it may be concluded that the true value for the coefficient measuring assortative pairing in respect to length in Paramecium lies between ·5 and ·6.

6. A considerable degree of homogamic correlation between the breadths of the members of conjugant pairs was found. It is believed to be a result of direct assortative pairing with respect to length, and of the organic correlation between length and breadth in the individual. The same explanation is to be given for the cross assortative correlations which were observed.

7. The homogamic correlations are not due to any local environmental factor, tending to make all conjugants relatively alike, because if conjugants be paired together at random, all homogamic correlation disappears.

8. The homogamic correlations are not greater in late stages of conjugation than in early, hence it is not probable that they owe their existence to any process of equalization of size due to the act of conjugation itself.

9. Evidence is presented to show that the homogamic correlation arises through the necessity for the anterior ends and mouths of the two members of a pair to "fit" reasonably well in a successful conjugation. The method by which this is probably brought about is discussed.

10. One general result of the work is to indicate strongly that the relation of the Protozoa to evolution problems is not that usually assigned on the Weismannian hypothesis. With reference to the evolutionary history of the race, the conjugant individuals of the protozoan population appear to be in certain respects comparable to the germ cells of metazoan. In order that there should be any *real* evolutionary progress in the Protozoa, it seems to be necessary that there be definite changes in these differentiated conjugant individuals, or in what has been called in this paper the *conjugant type*. What Paramecium may acquire during a cycle of fission generations as a result of environmental action is of no consequence in the evolution of the race if at the end of the cycle the individuals must come back to a relatively fixed type (the conjugant) before starting on the next cycle.

Appendix of Measurements.

In this section are given the correlation tables from which the constants have been deduced. In order to facilitate reference to these tables those of a particular series are grouped together, and are designated with the letter of the series and the number of the table within the series. The order in which the tables are given for each series is as follows:

1. The organic correlation tables for conjugants and non-conjugants.
2. The direct homogamic tables.
3. The cross homogamic tables.
4. Random or other tables.

For series *B* and *D* the measurements are given in full, as no correlation tables were formed for these very short series.

TABLE *A* 1.

Series A. Correlation of Length and Breadth for All Conjugants.

Breadth in microns.

Length in microns.	*33—35·9*	*36—38·9*	*39—41·9*	*42—44·9*	*45—47·9*	*48—50·9*	*51—53·9*	*54—56·9*	*57—59·9*	*60—62·9*	Totals
140—144	—	1	2	1	—	—	—	—	—	—	4
145—149	1	1	2	7	2	—	—	—	—	—	13
150—154	—	1	3	4	—	2	1	—	—	—	11
155—159	—	—	7	7	3	4	—	—	—	—	21
160—164	—	7	4	5	5	2	1	—	—	—	24
165—169	—	5	10	8	14	4	3	—	—	—	44
170—174	—	1	7	9	12	4	1	—	—	—	34
175—179	—	2	3	12	7	5	1	2	—	—	32
180—184	1	—	2	3	5	4	2	—	—	—	17
185—189	—	—	1	2	1	—	—	—	—	—	4
190—194	—	—	1	1	1	—	—	—	—	—	3
195—199	—	—	—	—	1	—	1	—	—	1	3
Totals	2	18	42	59	51	25	10	2	0	1	210

TABLE *A* 2.

Series A. Correlation of Length with Breadth for All Non-Conjugants.

Breadth in microns.

Length in microns.	*36—38·9*	*39—41·9*	*42—44·9*	*45—47·9*	*48—50·9*	*51—53·9*	*54—56·9*	*57—59·9*	*60—62·9*	*63—65·9*	*66—68·9*	*69—71·9*	Totals
145—149	—	1	—	—	—	—	—	—	—	—	—	—	1
150—154	—	—	—	—	1	—	—	—	—	—	—	—	1
155—159	—	—	1	1	—	—	—	—	—	—	—	—	2
160—164	—	—	1	—	1	1	—	—	—	—	—	—	3
165—169	—	—	2	5	4	1	3	1	—	—	—	—	16
170—174	—	—	4	4	—	3	—	—	—	—	—	—	11
175—179	—	—	1	7	4	3	4	1	—	—	—	—	20
180—184	1	2	—	4	6	7	3	2	3	—	—	—	28
185—189	—	—	—	5	6	7	3	6	1	—	—	—	28
190—194	—	—	1	3	2	7	8	5	2	—	—	—	28
195—199	—	—	3	1	1	7	5	3	1	—	—	—	21
200—204	—	—	—	—	3	3	1	4	2	—	—	1	14
205—209	—	—	—	—	1	1	2	2	3	2	—	—	11
210—214	—	—	—	—	—	2	2	4	3	1	—	—	12
215—219	—	—	—	—	—	2	2	3	1	—	1	—	9
220—224	—	—	—	—	—	—	1	—	—	—	—	—	1
225—229	—	—	—	—	—	—	—	1	—	—	1	—	2
230—234	—	—	—	—	—	—	—	—	1	—	—	1	2
Totals	1	3	13	30	29	44	34	32	17	3	2	2	210

TABLE *A* 3.

Series A. Direct Homogamic Correlation. Length of A and Length of B. Each Pair entered Once.

Length of *A* in microns.

Length of *B* in microns.	*140—144*	*145—149*	*150—154*	*155—159*	*160—164*	*165—169*	*170—174*	*175—179*	*180—184*	*185—189*	*190—194*	*195—199*	Totals
140—144	—	2	—	—	—	—	—	—	—	—	—	—	2
145—149	1	1	1	2	2	1	—	—	—	—	—	—	8
150—154	1	—	1	1	—	—	1	2	—	—	—	—	6
155—159	—	—	1	2	2	3	1	1	—	1	—	—	11
160—164	—	1	1	1	4	1	—	1	—	—	—	—	9
165—169	—	1	1	3	4	4	8	—	1	—	—	—	22
170—174	—	—	—	—	1	3	4	1	2	—	—	1	12
175—179	—	—	—	1	1	5	6	2	2	2	—	—	19
180—184	—	—	—	—	1	5	—	3	1	—	—	1	11
185—189	—	—	—	—	—	—	—	1	—	—	—	—	1
190—194	—	—	—	—	—	—	2	1	—	—	—	—	3
195—199	—	—	—	—	—	—	—	1	—	—	—	—	1
Totals	2	5	5	10	15	22	22	13	6	3	0	2	105

TABLE *A* 4.

Series A. Direct Homogamic Correlation. Length of A and Length of B. Symmetrical Table.

Length of first conjugant in microns.

Length of second conjugant in microns.	*140—144*	*145—149*	*150—154*	*155—159*	*160—164*	*165—169*	*170—174*	*175—179*	*180—184*	*185—189*	*190—194*	*195—199*	Totals
140—144	—	3	1	—	—	—	—	—	—	—	—	—	4
145—149	3	2	1	2	3	2	—	—	—	—	—	—	13
150—154	1	1	2	2	1	1	1	2	—	—	—	—	11
155—159	—	2	2	4	3	6	1	2	—	1	—	—	21
160—164	—	3	1	3	8	5	1	2	1	—	—	—	24
165—169	—	2	1	6	5	8	11	5	6	—	—	—	44
170—174	—	—	1	1	1	11	8	7	2	—	2	1	34
175—179	—	—	2	2	2	5	7	4	5	3	1	1	32
180—184	—	—	—	—	1	6	2	5	2	—	—	1	17
185—189	—	—	—	1	—	—	—	3	—	—	—	—	4
190—194	—	—	—	—	—	—	2	1	—	—	—	—	3
195—199	—	—	—	—	—	—	1	1	1	—	—	—	3
Totals	4	13	11	21	24	44	34	32	17	4	3	3	210

TABLE *A* 5.

Series A. Direct Homogamic Correlation. Breadth of A and Breadth of B. Each Pair entered Once.

Breadth of *A* in microns.

Breadth of *B* in microns.

	33—35·9	*36—38·9*	*39—41·9*	*42—44·9*	*45—47·9*	*48—50·9*	*51—53·9*	Totals
33—35·9	—	—	—	1	—	—	—	1
36—38·9	1	1	1	—	2	—	—	5
39—41·9	—	4	6	3	2	—	—	15
42—44·9	—	6	11	7	3	1	1	29
45—47·9	—	1	4	10	8	6	1	30
48—50·9	—	—	3	5	6	1	1	16
51—53·9	—	—	1	4	—	—	1	6
54—56·9	—	1	—	—	—	1	—	2
57—59·9	—	—	—	—	—	—	—	0
60—62·9	—	—	1	—	—	—	—	1
Totals	1	13	27	30	21	9	4	105

TABLE *A* 6.

Series A. Direct Homogamic Correlation. Breadth of A and Breadth of B. Symmetrical Table.

Breadth of first conjugant in microns.

Breadth of second conjugant in microns.

	33—35·9	*36—38·9*	*39—41·9*	*42—44·9*	*45—47·9*	*48—50·9*	*51—53·9*	*54—56·9*	*57—59·9*	*60—62·9*	Totals
33—35·9	—	1	—	1	—	—	—	—	—	—	2
36—38·9	1	2	5	6	3	—	—	1	—	—	18
39—41·9	—	5	12	14	6	3	1	—	—	1	42
42—44·9	1	6	14	14	13	6	5	—	—	—	59
45—47·9	—	3	6	13	16	12	1	—	—	—	51
48—50·9	—	—	3	6	12	2	1	1	—	—	25
51—53·9	—	—	1	5	1	1	2	—	—	—	10
54—56·9	—	1	—	—	—	1	—	—	—	—	2
57—59·9	—	—	—	—	—	—	—	—	—	—	0
60—62·9	—	—	1	—	—	—	—	—	—	—	1
Totals	2	18	42	59	51	25	10	2	0	1	210

TABLE *A* 7.

Series A. Direct Homogamic Correlation. Index of A and Index of B. Each Pair entered Once.

Index of *A* in per cent.

Index of *B* in per cent.

	20—20·9	*21—21·9*	*22—22·9*	*23—23·9*	*24—24·9*	*25—25·9*	*26—26·9*	*27—27·9*	*28—28·9*	*29—29·9*	*30—30·9*	*31—31·9*	*32—32·9*	Totals
19—19·9	—	—	—	—	1	—	—	—	—	—	—	—	—	1
20—20·9	—	—	—	—	—	—	1	—	—	—	—	—	—	1
21—21·9	—	—	—	—	—	—	—	—	—	—	—	—	—	0
22—22·9	—	1	—	1	1	—	—	1	—	—	—	—	—	4
23—23·9	1	—	—	5	2	2	1	—	—	—	—	—	—	11
24—24·9	—	2	—	1	1	1	—	1	1	—	—	—	—	7
25—25·9	—	2	1	2	4	3	1	1	1	1	—	—	—	16
26—26·9	—	1	1	3	2	1	5	1	1	1	—	2	—	18
27—27·9	1	—	1	1	—	1	4	2	1	2	—	—	—	13
28—28·9	—	—	1	2	3	—	1	—	3	1	—	—	—	11
29—29·9	—	—	—	—	1	1	1	4	—	—	—	—	—	7
30—30·9	—	—	1	—	—	2	2	1	—	3	—	1	—	10
31—31·9	—	—	1	—	—	—	—	—	—	—	—	1	1	3
32—32·9	—	—	—	—	—	—	—	1	—	1	—	—	—	2
33—33·9	—	—	—	—	—	—	—	1	—	—	—	—	—	1
Totals	2	6	6	15	15	11	16	13	7	9	0	4	1	105

TABLE *A* 8.

Series A. Direct Homogamic Correlation. Index of A and Index of B. Symmetrical Table.

Index of first conjugant in per cent.

Index of second conjugant in per cent.

	19—19·9	*20—20·9*	*21—21·9*	*22—22·9*	*23—23·9*	*24—24·9*	*25—25·9*	*26—26·9*	*27—27·9*	*28—28·9*	*29—29·9*	*30—30·9*	*31—31·9*	*32—32·9*	*33—33·9*	Totals
19—19·9	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
20—20·9	—	—	—	—	1	—	—	1	1	—	—	—	—	—	—	3
21—21·9	—	—	—	1	—	2	2	1	—	—	—	—	—	—	—	6
22—22·9	—	—	1	—	1	1	1	1	2	1	—	1	1	—	—	10
23—23·9	—	1	—	1	10	3	4	4	1	2	—	—	—	—	—	26
24—24·9	1	—	2	1	3	2	5	2	1	4	1	—	—	—	—	22
25—25·9	—	—	2	1	4	5	6	2	2	1	2	2	—	—	—	27
26—26·9	—	1	1	1	4	2	2	10	5	2	2	2	2	—	—	34
27—27·9	—	1	—	2	1	1	2	5	4	1	6	1	—	1	1	26
28—28·9	—	—	—	1	2	4	1	2	1	6	1	—	—	—	—	18
29—29·9	—	—	—	—	—	1	2	2	6	1	—	3	—	1	—	16
30—30·9	—	—	—	1	—	—	2	2	1	—	3	—	1	—	—	10
31—31·9	—	—	—	1	—	—	—	2	—	—	—	1	2	1	—	7
32—32·9	—	—	—	—	—	—	—	—	1	—	1	—	1	—	—	3
33—33·9	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1
Totals	1	3	6	10	26	22	27	34	26	18	16	10	7	3	1	210

TABLE *A* 9.

Series A. Cross Homogamic Correlation. Length of A and Breadth of B.

Breadth of *B* in microns.

Length of *A* in microns.	*33—35·9*	*36—38·9*	*39—41·9*	*42—44·9*	*45—47·9*	*48—50·9*	*51—53·9*	*54—56·9*	*57—59·9*	*60—62·9*	Totals
140—144	—	—	—	1	—	1	—	—	—	—	2
145—149	—	1	1	1	1	—	1	—	—	—	5
150—154	—	1	—	1	—	2	1	—	—	—	5
155—159	—	1	—	5	4	—	—	—	—	—	10
160—164	—	—	3	4	5	1	1	1	—	—	15
165—169	—	1	4	6	5	5	1	—	—	—	22
170—174	—	—	2	5	8	5	2	—	—	—	22
175—179	1	—	2	3	5	1	—	—	—	1	13
180—184	—	—	1	1	2	1	—	1	—	—	6
185—189	—	—	2	1	—	—	—	—	—	—	3
190—194	—	—	—	—	—	—	—	—	—	—	0
195—199	—	1	—	1	—	—	—	—	—	—	2
Totals	1	5	15	29	30	16	6	2	0	1	105

TABLE *A* 10.

Series A. Cross Homogamic Correlation. Length of B and Breadth of A.

Breadth of *A* in microns.

Length of *B* in microns.	*33—35·9*	*36—38·9*	*39—41·9*	*42—44·9*	*45—47·9*	*48—50·9*	*51—53·9*	Totals
140—144	1	—	—	1	—	—	—	2
145—149	—	1	3	1	2	1	—	8
150—154	—	1	1	3	—	—	1	6
155—159	—	2	3	3	1	2	—	11
160—164	—	4	2	2	1	—	—	9
165—169	—	1	5	7	6	2	1	22
170—174	—	—	3	3	6	—	—	12
175—179	—	3	3	6	3	3	1	19
180—184	—	—	5	3	1	1	1	11
185—189	—	1	—	—	—	—	—	1
190—194	—	—	1	1	1	—	—	3
195—199	—	—	1	—	—	—	—	1
Totals	1	13	27	30	21	9	4	105

TABLE *A* 11.

Series A. Random Pairing. Length with Length for Conjugants.
Symmetrical Table.

Length of first individual in microns.

Length of second individual in microns.

	140—144	*145—149*	*150—154*	*155—159*	*160—164*	*165—169*	*170—174*	*175—179*	*180—184*	*185—189*	*190—194*	*195—199*	Totals
140—144	—	—	—	—	3	—	1	—	—	—	—	—	4
145—149	—	—	2	—	1	3	3	1	2	—	1	—	13
150—154	—	2	—	1	—	1	1	3	—	2	—	1	11
155—159	—	—	1	6	1	3	3	5	—	1	—	1	21
160—164	3	1	—	1	6	3	4	4	2	—	—	—	24
165—169	—	3	1	3	3	8	12	8	3	1	2	—	44
170—174	1	3	1	3	4	12	4	2	4	—	—	—	34
175—179	—	1	3	5	4	8	2	6	3	—	—	—	32
180—184	—	2	—	—	2	3	4	3	2	—	—	1	17
185—189	—	—	2	1	—	1	—	—	—	—	—	—	4
190—194	—	1	—	—	—	2	—	—	—	—	—	—	3
195—199	—	—	1	1	—	—	—	—	1	—	—	—	3
Totals	4	13	11	21	24	44	34	32	17	4	3	3	210

TABLE *A* 12.

Series A. Random Pairing. Length with Length for Non-Conjugants.
Symmetrical Table.

Length of first individual in microns.

Length of second individual in microns.

	145—149	*150—154*	*155—159*	*160—164*	*165—169*	*170—174*	*175—179*	*180—184*	*185—189*	*190—194*	*195—199*	*200—204*	*205—209*	*210—214*	*215—219*	*220—224*	*225—229*	*230—234*	Totals
145—149	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1
150—154	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
155—159	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	2
160—164	—	—	—	—	—	—	—	—	—	2	—	—	1	—	—	—	—	—	3
165—169	—	—	—	—	—	2	4	2	2	2	2	1	—	—	1	—	—	—	16
170—174	1	—	—	—	2	—	2	1	—	3	1	—	—	1	—	—	—	—	11
175—179	—	—	—	—	4	2	—	3	2	2	3	—	—	—	3	—	—	1	20
180—184	—	—	1	—	2	1	3	8	4	—	2	3	1	3	—	—	—	—	28
185—189	—	1	—	—	2	—	2	4	8	2	4	1	3	—	—	—	1	—	28
190—194	—	—	1	2	2	3	2	—	2	—	4	3	3	4	2	—	—	—	28
195—199	—	—	—	—	2	1	3	2	4	4	—	2	1	—	—	—	1	1	21
200—204	—	—	—	—	1	—	—	3	1	3	2	—	—	1	3	—	—	—	14
205—209	—	—	—	1	—	—	—	1	3	3	1	—	—	1	—	1	—	—	11
210—214	—	—	—	—	—	1	—	3	—	4	—	1	1	2	—	—	—	—	12
215—219	—	—	—	—	1	—	3	—	—	2	—	3	—	—	—	—	—	—	9
220—224	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1
225—229	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	2
230—234	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	2
Totals	1	1	2	3	16	11	20	28	28	28	21	14	11	12	9	1	2	2	210

TABLE *A* 13.

Series A. Random Pairing. Length of Conjugants with Length of Non-Conjugants.

Length of Conjugants in microns.

Length of Non-Conjugants in microns.	*140—144*	*145—149*	*150—154*	*155—159*	*160—164*	*165—169*	*170—174*	*175—179*	*180—184*	*185—189*	*190—194*	*195—199*	Totals
145—149	—	1	—	—	—	—	—	—	—	—	—	—	1
150—154	—	—	—	—	—	1	—	—	—	—	—	—	1
155—159	—	—	—	—	—	—	—	—	1	1	—	—	2
160—164	—	—	1	—	—	1	1	—	—	—	—	—	3
165—169	—	1	—	3	3	5	1	2	1	—	—	—	16
170—174	—	—	—	1	1	1	2	2	4	—	—	—	11
175—179	—	2	1	4	3	2	3	5	—	—	—	—	20
180—184	1	—	1	2	6	7	4	5	2	—	—	—	28
185—189	—	1	1	4	4	5	5	3	2	2	1	—	28
190—194	2	1	2	2	3	5	7	3	2	—	1	—	28
195—199	—	2	1	3	2	—	4	6	2	—	—	1	21
200—204	1	1	2	1	—	4	2	2	1	—	—	—	14
205—209	—	1	—	—	1	5	2	1	—	—	—	1	11
210—214	—	2	2	—	1	3	—	—	1	1	1	1	12
215—219	—	1	—	1	—	5	—	2	—	—	—	—	9
220—224	—	—	—	—	—	—	1	—	—	—	—	—	1
225—229	—	—	—	—	—	—	2	—	—	—	—	—	2
230—234	—	—	—	—	—	—	—	1	1	—	—	—	2
Totals	4	13	11	21	24	44	34	32	17	4	3	3	210

TABLE *A* 14.

Series A. Random Pairing. Length with Length for the two Non-Conjugant Individuals nearest to each Pair of Conjugants Measured. Symmetrical Table.

Length in microns.

Length in microns.	*145—149*	*150—154*	*155—159*	*160—164*	*165—169*	*170—174*	*175—179*	*180—184*	*185—189*	*190—194*	*195—199*	*200—204*	*205—209*	*210 - 214*	*215—219*	*220—224*	*225—229*	*230—234*	Totals
145—149	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
150—154	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1
155—159	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	2
160—164	1	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	3
165—169	—	—	—	—	2	1	2	2	4	3	1	1	—	—	—	—	—	—	16
170—174	—	—	—	—	1	—	1	1	1	2	1	1	—	1	2	—	—	—	11
175—179	—	—	1	—	2	1	—	3	2	4	2	1	1	1	—	—	1	1	20
180—184	—	—	1	1	2	1	3	—	5	5	3	2	2	2	—	1	—	—	28
185—189	—	—	—	1	4	1	2	5	4	1	3	2	3	—	2	—	—	—	28
190—194	—	—	—	—	3	2	4	5	1	4	3	1	1	2	2	—	—	—	28
195—199	—	—	—	—	1	1	2	3	3	3	4	1	—	2	—	—	1	—	21
200—204	—	—	—	—	1	1	1	2	2	1	1	2	1	1	1	—	—	—	14
205—209	—	—	—	—	—	—	1	2	3	1	—	1	—	2	1	—	—	—	11
210—214	—	—	—	—	—	1	1	2	—	2	2	1	2	—	—	—	—	1	12
215—219	—	1	—	—	—	2	—	—	2	2	—	1	1	—	—	—	—	—	9
220—224	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1
225—229	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	2
230—234	—	—	—	—	—	—	1	—	—	—	—	—	—	1	—	—	—	—	2
Totals	1	1	2	3	16	11	20	28	28	28	21	14	11	12	9	1	2	2	210

TABLE *B* 1.

Series B. Measurements in microns of the Length and Breadth of Conjugants and Non-Conjugants.

	Conjugants		Non-Conjugants	
	Length	Breadth	Length	Breadth
A	159	43	165	57
B	154	40	182	54
A	183	41	225	57
B	185	42	184	49
A	165	43	217	50
B	165	39	194	47
A	163	44	181	45
B	160	41	216	56
A	177	48	210	52
B	173	41	216	54
A	151	43	215	57
B	155	47	204	57
A	178	50	196	50
B	171	43	213	49
A	158	36	205	50
B	168	39	205	47
A	178	45	194	52
B	165	39	204	56
A	205	54	196	49
B	184	41	200	52
A	192	47	193	47
B	177	43	198	45
A	127	41	190	52
B	143	42	190	52

TABLE *C* 1.

Series C. Correlation of Length with Breadth for All Conjugants.

Breadth in microns.

Length in microns.	*30—32·9*	*33—35·9*	*36—38·9*	*39—41·9*	*42—44·9*	*45—47·9*	*48—50·9*	*51—53·9*	*54—56·9*	Totals
140—144	—	—	—	1	—	—	—	—	—	1
145—149	—	—	—	1	2	—	—	—	—	3
150—154	—	—	—	5	4	—	—	—	—	9
155—159	—	1	2	4	3	1	—	—	—	11
160—164	—	—	3	4	8	2	1	—	—	18
165—169	1	—	6	4	12	9	2	—	—	34
170—174	—	—	2	3	10	3	—	—	—	18
175—179	—	—	1	5	9	5	2	—	—	22
180—184	—	—	3	5	10	8	3	—	—	29
185—189	—	—	1	4	7	8	—	—	—	20
190—194	—	1	—	9	8	3	4	—	1	26
195—199	—	—	1	1	3	—	2	1	—	8
200—204	—	—	1	1	1	—	—	—	—	3
Totals	1	2	20	47	77	39	14	1	1	202

TABLE *C* 2.

Series C. Correlation of Length with Breadth for All Non-Conjugants.

Breadth in microns.

Length in microns.	*39—41·9*	*42—44·9*	*45—47·9*	*48—50·9*	*51—53·9*	*54—56·9*	*57—59·9*	*60—62·9*	*63—65·9*	*66—68·9*	*69—71·9*	*72—74·9*	*75—77·9*	Totals
140—149	—	1	—	—	—	—	—	—	—	—	—	—	—	1
150—159	—	—	—	—	—	—	—	—	—	—	—	—	—	0
160—169	1	1	—	1	—	—	—	—	—	—	—	—	—	3
170—179	—	2	4	1	—	—	—	—	—	—	—	—	—	7
180—189	—	1	2	7	7	4	1	1	—	—	—	—	—	23
190—199	1	5	—	6	5	8	4	—	—	—	—	—	—	29
200—209	—	3	6	5	6	16	1	2	—	—	—	—	—	39
210—219	—	1	2	4	7	13	6	4	2	—	—	—	—	39
220—229	—	—	—	2	7	7	11	4	2	2	—	—	—	35
230—239	—	—	—	—	3	4	3	3	—	1	—	—	—	14
240—249	—	—	—	—	1	2	—	1	3	1	1	—	—	9
250—259	—	—	—	—	—	—	1	—	1	—	—	—	1	3
Totals	2	14	14	26	36	54	27	15	8	4	1	0	1	202

TABLE *C* 3.

Series C. Direct Homogamic Correlation. Length of A and Length of B. Each Pair entered Once.

Length of *A* in microns.

Length of *B* in microns.	*145—149*	*150—154*	*155—159*	*160—164*	*165—169*	*170—174*	*175—179*	*180—184*	*185—189*	*190—194*	*195—199*	*200—204*	Totals
140—144	—	—	—	—	1	—	—	—	—	—	—	—	1
145—149	—	—	—	—	1	—	—	—	—	—	—	—	1
150—154	—	1	1	—	1	1	—	—	—	—	—	—	4
155—159	1	2	1	3	—	—	—	—	—	—	—	—	7
160—164	—	—	1	1	6	1	1	2	—	—	—	—	12
165—169	—	2	1	2	2	2	—	1	—	—	—	—	10
170—174	—	—	—	—	6	1	1	—	—	—	1	—	9
175—179	—	—	—	—	4	1	1	4	1	—	—	—	11
180—184	1	—	—	—	2	2	6	1	—	2	3	—	17
185—189	—	—	—	—	—	1	1	4	5	2	—	—	13
190—194	—	—	—	—	1	—	1	—	1	7	2	1	13
195—199	—	—	—	—	—	—	—	—	—	2	—	—	2
200—204	—	—	—	—	—	—	—	—	—	—	—	1	1
Totals	2	5	4	6	24	9	11	12	7	13	6	2	101

TABLE *C* 4.

Series C. Direct Homogamic Correlation. Length of A and Length of B. Symmetrical Table.

Length of first conjugant in microns.

Length of second conjugant in microns.	*140—144*	*145—149*	*150—154*	*155—159*	*160—164*	*165—169*	*170—174*	*175—179*	*180—184*	*185—189*	*190—194*	*195—199*	*200—204*	Totals
140—144	—	—	—	—	—	1	—	—	—	—	—	—	—	1
145—149	—	—	—	1	—	1	—	—	1	—	—	—	—	3
150—154	—	—	2	3	—	3	1	—	—	—	—	—	—	9
155—159	—	1	3	2	4	1	—	—	—	—	—	—	—	11
160—164	—	—	—	4	2	8	1	1	2	—	—	—	—	18
165—169	1	1	3	1	8	4	8	4	3	—	1	—	—	34
170—174	—	—	1	—	1	8	2	2	2	1	—	1	—	18
175—179	—	—	—	—	1	4	2	2	10	2	1	—	—	22
180—184	—	1	—	—	2	3	2	10	2	4	2	3	—	29
185—189	—	—	—	—	—	—	1	2	4	10	3	—	—	20
190—194	—	—	—	—	—	1	—	1	2	3	14	4	1	26
195—199	—	—	—	—	—	—	1	—	3	—	4	—	—	8
200—204	—	—	—	—	—	—	—	—	—	—	1	—	2	3
Totals	1	3	9	11	18	34	18	22	29	20	26	8	3	202

TABLE *C* 5.

Series C. Direct Homogamic Correlation. Breadth of A and Breadth of B. Each Pair entered Once.

Breadth of *A* in microns.

Breadth of *B* in microns.	*30—32·9*	*33—35·9*	*36—38·9*	*39—41·9*	*42—44·9*	*45—47·9*	*48—50·9*	*51—53·9*	Totals
33—35·9	—	—	—	—	1	—	—	—	1
36—38·9	1	1	1	4	1	2	—	—	10
39—41·9	—	—	5	6	7	3	1	—	22
42—44·9	—	—	3	9	16	5	4	—	37
45—47·9	—	—	1	5	10	6	—	—	22
48—50·9	—	—	—	1	5	1	—	1	8
51—53·9	—	—	—	—	—	—	—	—	0
54—56·9	—	—	—	—	—	—	1	—	1
Totals	1	1	10	25	40	17	6	1	101

TABLE *C* 6.

Series C. Direct Homogamic Correlation. Breadth of A and Breadth of B. Symmetrical Table.

Breadth of first conjugant in microns.

Breadth of second conjugant in microns.	*30—32·9*	*33—35·9*	*36—38·9*	*39—41·9*	*42—44·9*	*45—47·9*	*48—50·9*	*51—53·9*	*54—56·9*	Totals
30—32·9	—	—	1	—	—	—	—	—	—	1
33—35·9	—	—	1	—	1	—	—	—	—	2
36—38·9	1	1	2	9	4	3	—	—	—	20
39—41·9	—	—	9	12	16	8	2	—	—	47
42—44·9	—	1	4	16	32	15	9	—	—	77
45—47·9	—	—	3	8	15	12	1	—	—	39
48—50·9	—	—	—	2	9	1	—	1	1	14
51—53·9	—	—	—	—	—	—	1	—	—	1
54—56·9	—	—	—	—	—	—	1	—	—	1
Totals	1	2	20	47	77	39	14	1	1	202

TABLE *C* 7.

Series C. Direct Homogamic Correlation. Index of A and Index of B. Each Pair entered Once.

Index of *A* in per cent.

Index of *B* in per cent.	*18—18·9*	*19—19·9*	*20—20·9*	*21—21·9*	*22—22·9*	*23—23·9*	*24—24·9*	*25—25·9*	*26—26·9*	*27—27·9*	*28—28·9*	Totals
18—18·9	—	—	—	1	—	—	—	—	—	—	—	1
19—19·9	—	—	—	—	—	—	—	—	—	—	—	0
20—20·9	1	—	—	3	—	1	—	—	—	1	—	6
21—21·9	—	—	1	2	1	1	—	—	—	—	—	5
22—22·9	1	1	—	2	3	—	3	3	2	1	—	16
23—23·9	—	1	—	2	4	2	2	2	—	—	1	14
24—24·9	—	—	1	—	2	4	2	2	1	—	1	13
25—25·9	—	—	—	2	3	2	—	2	3	1	2	15
26—26·9	—	—	—	1	1	1	2	6	1	1	1	14
27—27·9	—	—	—	—	—	1	2	2	3	1	2	11
28—28·9	—	—	—	—	—	—	1	—	—	1	—	2
29—29·9	—	—	—	—	—	—	—	1	—	—	1	2
30—30·9	—	—	—	—	—	—	—	—	1	1	—	2
Totals	2	2	2	13	14	12	12	18	11	7	8	101

TABLE *C* 8.

Series C. Direct Homogamic Correlation. Index of A and Index of B. Symmetrical Table.

Index of first individual in per cent.

Index of second individual in per cent.	*18—18·9*	*19—19·9*	*20—20·9*	*21—21·9*	*22—22·9*	*23—23·9*	*24—24·9*	*25—25·9*	*26—26·9*	*27—27·9*	*28—28·9*	*29—29·9*	*30—30·9*	Totals
18—18·9	—	—	1	1	1	—	—	—	—	—	—	—	—	3
19—19·9	—	—	—	—	1	1	—	—	—	—	—	—	—	2
20—20·9	1	—	—	4	—	1	1	—	—	1	—	—	—	8
21—21·9	1	—	4	4	3	3	—	2	1	—	—	—	—	18
22—22·9	1	1	—	3	6	4	5	6	3	1	—	—	—	30
23—23·9	—	1	1	3	4	4	6	4	1	1	1	—	—	26
24—24·9	—	—	1	—	5	6	4	2	3	2	2	—	—	25
25—25·9	—	—	—	2	6	4	2	4	9	3	2	1	—	33
26—26·9	—	—	—	1	3	1	3	9	2	4	1	—	1	25
27—27·9	—	—	1	—	1	1	2	3	4	2	3	—	1	18
28—28·9	—	—	—	—	—	1	2	2	1	3	—	1	—	10
29—29·9	—	—	—	—	—	—	—	1	—	—	1	—	—	2
30—30·9	—	—	—	—	—	—	—	—	1	1	—	—	—	2
Totals	3	2	8	18	30	26	25	33	25	18	10	2	2	202

TABLE *C* 9.

Series C. Cross Homogamic Correlation. Length of A and Breadth of B.

Breadth of *B* in microns.

Length of *A* in microns.	*33—35·9*	*36—38·9*	*39—41·9*	*42—44·9*	*45—47·9*	*48—50·9*	*51—53·9*	*54—56·9*	Totals
145—149	—	—	1	—	1	—	—	—	2
150—154	—	—	—	2	3	—	—	—	5
155—159	—	1	1	2	—	—	—	—	4
160—164	—	2	2	1	—	1	—	—	6
165—169	—	3	4	11	5	1	—	—	24
170—174	—	2	3	3	1	—	—	—	9
175—179	—	—	1	5	3	1	—	1	11
180—184	—	—	4	3	5	—	—	—	12
185—189	—	1	1	2	2	1	—	—	7
190—194	—	1	4	4	2	2	—	—	13
195—199	1	—	—	4	—	1	—	—	6
200—204	—	—	1	—	—	1	—	—	2
Totals	1	10	22	37	22	8	0	1	101

TABLE *C* 10.

Series C. Cross Homogamic Correlation. Length of B and Breadth of A.

Breadth of *A* in microns.

Length of *B* in microns.	*30—32·9*	*33—35·9*	*36—38·9*	*39—41·9*	*42—44·9*	*45—47·9*	*48—50·9*	*51—53·9*	Totals
140—144	—	—	—	1	—	—	—	—	1
145—149	—	—	—	—	1	—	—	—	1
150—154	—	—	1	1	2	—	—	—	4
155—159	—	1	1	1	3	1	—	—	7
160—164	1	—	—	2	6	2	1	—	12
165—169	—	—	1	3	5	1	—	—	10
170—174	—	—	1	2	2	2	2	—	9
175—179	—	—	2	3	2	4	—	—	11
180—184	—	—	1	4	8	2	1	1	17
185—189	—	—	2	4	4	3	—	—	13
190—194	—	—	—	3	6	2	2	—	13
195—199	—	—	—	1	1	—	—	—	2
200—204	—	—	1	—	—	—	—	—	1
Totals	1	1	10	25	40	17	6	1	101

TABLE *C* 11.

Series C. Random Pairing. Length with Length for Conjugants. Symmetrical Table.

Length of first individual in microns.

Length of second individual in microns.	*140—144*	*145—149*	*150—154*	*155—159*	*160—164*	*165—169*	*170—174*	*175—179*	*180—184*	*185—189*	*190—194*	*195—199*	*200—204*	Totals
140—144	—	—	—	—	—	—	—	—	—	1	—	—	—	1
145—149	—	—	—	—	1	1	1	—	—	—	—	—	—	3
150—154	—	—	—	1	2	—	—	—	2	1	3	—	—	9
155—159	—	—	1	—	—	4	2	1	2	—	1	—	—	11
160—164	—	1	2	—	—	2	2	4	—	2	3	2	—	18
165—169	—	1	—	4	2	8	4	1	5	5	2	1	1	34
170—174	—	1	—	2	2	4	—	3	3	—	3	—	—	18
175—179	—	—	—	1	4	1	3	8	2	—	1	1	1	22
180—184	—	—	2	2	—	5	3	2	6	2	5	2	—	29
185—189	1	—	1	—	2	5	—	—	2	4	4	—	1	20
190—194	—	—	3	1	3	2	3	1	5	4	4	—	—	26
195—199	—	—	—	—	2	1	—	1	2	—	—	2	—	8
200—204	—	—	—	—	—	1	—	1	—	1	—	—	—	3
Totals	1	3	9	11	18	34	18	22	29	20	26	8	3	202

TABLE *C* 12.

Series C. Random Pairing. Length with Length for Non-Conjugants. Symmetrical Table.

Length of first individual in microns.

Length of second individual in microns.	*140—149*	*150—159*	*160—169*	*170—179*	*180—189*	*190—199*	*200—209*	*210—219*	*220—229*	*230—239*	*240—249*	*250—259*	Totals
140 –149	—	—	—	—	—	—	—	1	—	—	—	—	1
150—159	—	—	—	—	—	—	—	—	—	—	—	—	0
160—169	—	—	—	—	2	—	—	—	1	—	—	—	3
170—179	—	—	—	—	2	2	—	1	2	—	—	—	7
180—189	—	—	2	2	4	2	3	3	3	2	2	—	23
190—199	—	—	—	2	2	2	4	7	4	5	2	1	29
200—209	—	—	—	—	3	4	4	11	12	1	3	1	39
210—219	1	—	—	1	3	7	11	10	3	1	1	1	39
220—229	—	—	1	2	3	4	12	3	4	5	1	—	35
230—239	—	—	—	—	2	5	1	1	5	—	—	—	14
240—249	—	—	—	—	2	2	3	1	1	—	—	—	9
250—259	—	—	—	—	—	1	1	1	—	—	—	—	3
Totals	1	0	3	7	23	29	39	39	35	14	9	3	202

TABLE *C* 13.

Series C. Random Pairing. Length of Conjugants with Length of Non-Conjugants.

Length of conjugants in microns.

Length of non-conjugants in microns.

	140—144	*145—149*	*150—154*	*155—159*	*160—164*	*165—169*	*170—174*	*175—179*	*180—184*	*185—189*	*190—194*	*195—199*	*200—204*	Totals
140—149	—	—	—	—	—	—	—	—	1	—	—	—	—	1
150—159	—	—	—	—	—	—	—	—	—	—	—	—	—	0
160—169	—	—	—	—	—	—	1	—	1	1	—	—	—	3
170—179	—	—	—	—	1	—	—	—	1	2	2	1	—	7
180—189	—	—	1	—	2	8	1	4	—	4	3	—	—	23
190—199	—	1	2	5	2	6	2	3	2	1	4	1	—	29
200—209	—	1	2	1	7	5	2	3	6	5	6	—	1	39
210—219	1	—	1	2	2	2	5	6	7	2	6	3	2	39
220—229	—	1	3	2	2	6	3	2	5	5	4	2	—	35
230—239	—	—	—	1	2	3	2	1	4	—	1	—	—	14
240—249	—	—	—	—	—	3	2	3	1	—	—	—	—	9
250—259	—	—	—	—	—	1	—	—	1	—	—	1	—	3
Totals	1	3	9	11	18	34	18	22	29	20	26	8	3	202

TABLE *C* 14.

Series C. Random Pairing. Length with Length for the two Non-Conjugant Individuals nearest to each Pair of Conjugants Measured. Symmetrical Table.

Length of first individual in microns.

Length of second individual in microns.

	140—149	*150—159*	*160—169*	*170—179*	*180—189*	*190—199*	*200—209*	*210—219*	*220—229*	*230—239*	*240—249*	*250—259*	Totals
140—149	—	—	—	—	—	1	—	—	—	—	—	—	1
150—159	—	—	—	—	—	—	—	—	—	—	—	—	0
160—169	—	—	—	—	1	—	1	—	1	—	—	—	3
170—179	—	—	—	—	2	1	2	2	—	—	—	—	7
180—189	—	—	1	2	2	4	3	3	6	1	1	—	23
190—199	1	—	—	1	4	6	3	5	4	3	1	1	29
200—209	—	—	1	2	3	3	6	11	6	6	1	—	39
210—219	—	—	—	2	3	5	11	8	5	3	2	—	39
220—229	—	—	1	—	6	4	6	5	10	—	2	1	35
230—239	—	—	—	—	1	3	6	3	—	—	—	1	14
240—249	—	—	—	—	1	1	1	2	2	—	2	—	9
250—259	—	—	—	—	—	1	—	—	1	1	—	—	3
Totals	1	0	3	7	23	29	39	39	35	14	9	3	202

TABLE *D* 1.

Series D. Measurements in microns of the Length and Breadth of Conjugants and Non-Conjugants.

	Conjugants		Non-Conjugants	
	Length	Breadth	Length	Breadth
A	150	40	197	51
B	189	43	189	50
A	200	38	213	50
B	202	41	189	50
A	189	41	206	57
B	191	41	212	54
A	168	43	199	50
B	161	43	213	50
A	180	44	207	50
B	184	45	217	49
A	180	47	223	59
B	200	45	210	53
A	196	43	225	49
B	182	40	199	45
A	169	43	203	47
B	184	48	228	52
A	198	36	216	51
B	184	41	230	57
A	183	37	232	54
B	186	44	197	49
A	186	45	217	56
B	167	42	235	56
A	160	43	168	44
B	158	42	241	54
A	184	43	243	57
B	189	47	230	54
A	175	42	225	60
B	167	44	241	60
A	194	39	241	54
B	189	43	230	56
A	188	44	223	54
B	188	44	266	56

TABLE *E* 1.

Series E. Correlation of Length with Breadth for All Non-Conjugants.

Breadth in microns.

Length in microns.	*45—47·9*	*48—50·9*	*51—53·9*	*54—56·9*	*57—59·9*	*60—62·9*	*63—65·9*	*66—68·9*	*69—71·9*	*72—74·9*	*75—77·9*	*78—80·9*	Totals
160—169	—	1	—	1	—	—	—	—	—	—	—	—	2
170—179	1	—	—	1	—	—	—	—	—	—	—	—	2
180—189	—	1	—	2	3	1	—	—	—	—	—	—	7
190—199	—	1	—	3	5	6	3	1	—	—	—	—	19
200—209	—	1	—	—	12	5	2	1	—	1	—	—	22
210—219	—	—	—	—	4	9	6	4	4	—	—	—	27
220—229	—	—	1	—	1	8	6	6	4	1	—	—	27
230—239	—	—	—	—	—	—	3	8	2	2	1	1	17
240—249	—	—	—	—	—	1	1	1	1	2	1	—	7
250—259	—	—	—	—	—	—	—	—	1	—	—	—	1
260—269	—	—	—	—	—	—	—	—	—	—	—	—	0
270—279	—	—	—	—	—	—	1	—	—	—	—	—	1
Totals	1	4	1	7	25	30	22	21	12	6	2	1	132

TABLE *E* 2.

Series E. Frequency Distribution of Length-Breadth Index for all Non-Conjugants.

Index in per cent.	*23—23·9*	*24—24·9*	*25—25·9*	*26—26·9*	*27—27·9*	*28—28·9*	*29—29·9*	*30—30·9*	*31—31·9*	*32—32·9*	*33—33·9*	*34—34·9*	*35—35·9*	Total
Frequency	2	1	3	6	18	27	23	21	13	11	5	1	1	132

TABLE *F* 1.

Series F Early. Direct Homogamic Correlation. Length of A, and Length of B. Each Pair entered Once. Micrometer unit = 8·6 *microns.*

Length of *B* in units.

Length of *A* in units.	*21—21·9*	*22—22·9*	*23—23·9*	*24—24·9*	*25—25·9*	*26—26·9*	*27—27·9*	*28—28·9*	*29—29·9*	Totals
20—20·9	3	1	—	—	—	—	—	—	—	4
21—21·9	—	3	—	3	—	—	—	—	—	6
22—22·9	3	3	2	1	—	—	—	—	—	9
23—23·9	1	4	4	1	1	—	—	—	—	11
24—24·9	1	3	3	3	2	4	—	—	—	16
25—25·9	—	1	2	3	—	3	—	1	—	10
26—26·9	—	—	2	3	1	1	—	1	—	8
27—27·9	—	—	1	—	—	1	—	—	—	2
28—28·9	—	—	—	—	—	—	1	—	1	2
29—29·9	—	—	—	—	—	—	1	1	—	2
Totals	8	15	14	14	4	9	2	3	1	70

TABLE *F* 2.

Series F Early. Direct Homogamic Correlation. Length of A and Length of B. Symmetrical Table. Micrometer unit = 8·6 *microns.*

Length of first individual in units.

Length of second individual in units.

	20—20·9	*21—21·9*	*22—22·9*	*23—23·9*	*24—24·9*	*25—25·9*	*26—26·9*	*27—27·9*	*28—28·9*	*29—29·9*	Totals
20—20·9	—	3	1	—	—	—	—	—	—	—	4
21—21·9	3	—	6	1	4	—	—	—	—	—	14
22—22·9	1	6	6	6	4	1	—	—	—	—	24
23—23·9	—	1	6	8	4	3	2	1	—	—	25
24—24·9	—	4	4	4	6	5	7	—	—	—	30
25—25·9	—	—	1	3	5	—	4	—	1	—	14
26—26·9	—	—	—	2	7	4	2	1	1	—	17
27—27·9	—	—	—	1	—	—	1	—	1	1	4
28—28·9	—	—	—	—	—	1	1	1	—	2	5
29—29·9	—	—	—	—	—	—	—	1	2	—	3
Totals	4	14	24	25	30	14	17	4	5	3	140

TABLE *F* 3.

Series F Late. Direct Homogamic Correlation. Length of A and Length of B. Each Pair entered Once. Micrometer unit = 8·6 *microns.*

Length of *B* in units.

Length of *A* in units.

	21—21·9	*22—22·9*	*23—23·9*	*24—24·9*	*25—25·9*	*26—26·9*	*27—27·9*	*28—28·9*	*29—29·9*	*30—30·9*	*31—31·9*	Totals
20—20·9	1	1	—	—	—	—	—	—	—	—	—	2
21—21·9	1	2	2	—	—	1	—	—	—	—	—	6
22—22·9	—	2	3	—	—	—	—	—	—	—	—	5
23—23·9	1	—	4	2	2	1	—	—	—	—	—	10
24—24·9	—	2	5	1	5	—	—	1	—	—	—	14
25—25·9	1	—	3	7	4	4	2	—	—	—	—	21
26—26·9	—	2	—	2	1	1	1	1	—	—	—	8
27—27·9	—	1	—	1	—	1	—	3	—	—	—	6
28—28·9	—	—	—	1	—	1	—	—	1	—	—	3
29—29·9	—	—	—	—	—	—	—	—	—	—	—	0
30—30·9	—	—	—	—	—	—	—	—	—	—	1	1
31—31·9	—	—	—	—	—	—	—	1	—	—	—	1
Totals	4	10	17	14	12	9	3	6	1	0	1	77

TABLE *F* 4.

Series F Late. Direct Homogamic Correlation. Length of A and Length of B. Symmetrical Table. Micrometer unit = 8·6 *microns.*

Length of first individual in units.

Length of second individual in units.	*20—20·9*	*21—21·9*	*22—22·9*	*23—23·9*	*24—24·9*	*25—25·9*	*26—26·9*	*27—27·9*	*28—28·9*	*29—29·9*	*30—30·9*	*31—31·9*	Totals
20—20·9	—	1	1	—	—	—	—	—	—	—	—	—	2
21—21·9	1	2	2	3	—	1	1	—	—	—	—	—	10
22—22·9	1	2	4	3	2	—	2	1	—	—	—	—	15
23—23·9	—	3	3	8	7	5	1	—	—	—	—	—	27
24—24·9	—	—	2	7	2	12	2	1	2	—	—	—	28
25—25·9	—	1	—	5	12	8	5	2	—	—	—	—	33
26—26·9	—	1	2	1	2	5	2	2	2	—	—	—	17
27—27·9	—	—	1	—	1	2	2	—	3	—	—	—	9
28—28·9	—	—	—	—	2	—	2	3	—	1	—	1	9
29—29·9	—	—	—	—	—	—	—	—	1	—	—	—	1
30—30·9	—	—	—	—	—	—	—	—	—	—	—	1	1
31—31·9	—	—	—	—	—	—	—	—	1	—	1	—	2
Totals	2	10	15	27	28	33	17	9	9	1	1	2	154

TABLE *AA* 1.

Series AA. Correlation of Length with Breadth for Conjugant A.

Length of *A* in microns.

Breadth of *A* in microns.	*160—169*	*170—179*	*180—189*	*190—199*	*200—209*	*210—219*	*220—229*	*230—239*	*240—249*	*250—259*	*260—269*	*270—279*	*280—289*	Totals
33—35·9	—	—	1	—	1	—	1	—	—	—	—	—	—	3
36—38·9	—	—	—	—	—	—	—	—	—	—	—	—	—	0
39—41·9	—	—	1	1	1	—	1	—	—	—	—	—	—	4
42—44·9	—	—	1	1	—	—	—	—	—	—	—	—	—	2
45—47·9	—	1	3	1	2	2	1	1	—	—	—	—	—	11
48—50·9	—	—	—	3	6	5	6	1	1	—	—	—	—	22
51—53·9	1	—	2	3	11	8	8	2	2	1	—	—	—	38
54—56·9	—	1	1	1	6	6	3	3	2	1	—	—	—	24
57—59·9	—	—	1	3	5	8	5	3	4	—	—	—	—	29
60—62·9	—	—	1	2	3	3	4	9	2	1	1	—	—	26
63—65·9	—	—	—	3	—	7	6	3	2	—	1	—	1	23
66—68·9	—	—	—	—	—	—	1	—	1	1	—	—	—	3
69—71·9	—	—	—	—	—	1	1	1	2	—	1	—	—	6
72—74·9	—	—	—	—	1	1	2	1	1	—	—	—	—	6
75—77·9	—	—	—	—	—	—	—	—	—	—	—	—	—	0
78—80·9	—	—	—	—	—	—	—	—	1	—	—	—	—	1
81—83·9	—	—	—	—	—	—	—	—	—	—	—	—	—	0
84—86·9	—	—	—	—	—	—	2	—	—	—	—	—	—	2
Totals	1	2	11	18	36	41	41	24	18	4	3	0	1	200

TABLE *AA* 2.

Series AA. Correlation of Length with Breadth for Conjugant B.

Breadth of *B* in microns.

Length of *B* in microns.

	27—29·9	*30—32·9*	*33—35·9*	*36—38·9*	*39—41·9*	*42—44·9*	*45—47·9*	*48—50·9*	*51—53·9*	*54—56·9*	*57—59·9*	*60—62·9*	*63—65·9*	*66—68·9*	*69—71·9*	*72—74·9*	*75—77·9*	*78—80·9*	*81—83·9*	*84—86·9*	*87—89·9*	*90—92·9*	Totals
160—169	—	—	—	—	—	1	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	3
170—179	—	—	—	—	—	—	—	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	3
180—189	—	—	—	—	—	—	1	1	—	1	1	—	—	—	—	—	—	—	—	—	—	—	4
190—199	—	—	—	—	—	1	2	1	2	6	2	1	—	1	2	—	—	—	—	—	—	—	18
200—209	1	—	—	—	1	3	2	4	16	6	10	3	4	—	2	—	—	—	1	—	—	—	53
210—219	—	—	—	—	2	5	1	6	7	6	6	6	1	1	—	—	—	—	—	—	—	—	41
220—229	—	—	—	—	1	1	2	3	6	3	3	3	2	—	3	—	—	—	—	—	—	—	27
230—239	—	—	—	—	1	—	2	1	3	8	4	2	1	—	2	1	—	—	—	—	—	—	25
240—249	—	—	—	—	—	—	2	—	—	—	2	2	1	—	3	1	—	2	—	—	—	—	13
250—259	—	—	—	—	—	—	—	—	—	—	2	1	2	—	2	1	—	—	—	—	—	1	9
260—269	—	—	—	—	—	—	—	—	—	—	2	—	1	—	—	—	—	—	—	—	—	1	4
Totals	1	0	0	0	5	11	12	18	36	31	32	18	12	2	14	3	0	2	1	0	0	2	200

TABLE *AA* 3.

Series AA. Direct Homogamic Correlation. Length of A and Length of B. Symmetrical Table.

Length of first individual in microns.

Length of second individual in microns.

	160—169	*170—179*	*180—189*	*190—199*	*200—209*	*210—219*	*220—229*	*230—239*	*240—249*	*250—259*	*260—269*	*270—279*	*280—289*	Totals
160—169	—	1	1	1	—	1	—	—	—	—	—	—	—	4
170—179	1	2	1	—	—	—	1	—	—	—	—	—	—	5
180—189	1	1	4	3	4	1	—	—	1	—	—	—	—	15
190—199	1	—	3	4	14	7	5	1	1	—	—	—	—	36
200—209	—	—	4	14	30	25	9	5	1	1	—	—	—	89
210—219	1	—	1	7	25	22	16	5	5	—	—	—	—	82
220—229	—	1	—	5	9	16	10	16	7	1	2	—	1	68
230—239	—	—	—	1	5	5	16	16	4	2	—	—	—	49
240—249	—	—	1	1	1	5	7	4	4	5	3	—	—	31
250—259	—	—	—	—	1	—	1	2	5	4	—	—	—	13
260—269	—	—	—	—	—	—	2	—	3	—	2	—	—	7
270—279	—	—	—	—	—	—	—	—	—	—	—	—	—	0
280—289	—	—	—	—	—	—	1	—	—	—	—	—	—	1
Totals	4	5	15	36	89	82	68	49	31	13	7	0	1	400

TABLE *AA* 4.

Series AA. Direct Homogamic Correlation. Breadth of A and Breadth of B. Symmetrical Table.

Breadth of first individual in microns.

Breadth of second individual in microns.	27—29·9	30—32·9	33—35·9	36—38·9	39—41·9	42—44·9	45—47·9	48—50·9	51—53·9	54—56·9	57—59·9	60—62·9	63—65·9	66—68·9	69—71·9	72—74·9	75—77·9	78—80·9	81—83·9	84—86·9	87—89·9	90—92·9	Totals
27—29·9	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
30—32·9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
33—35·9	—	—	—	—	—	—	2	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	3
36—38·9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
39—41·9	—	—	—	—	—	2	—	4	—	1	—	2	—	—	—	—	—	—	—	—	—	—	9
42—44·9	—	—	—	—	2	—	2	3	2	2	2	—	—	—	—	—	—	—	—	—	—	—	13
45—47·9	—	—	2	—	—	2	—	5	8	2	3	1	—	—	—	—	—	—	—	—	—	—	23
48—50·9	—	—	—	—	4	3	5	2	10	7	2	2	3	—	2	—	—	—	—	—	—	—	40
51—53·9	—	—	—	—	—	2	8	10	10	13	11	12	4	3	—	1	—	—	—	—	—	—	74
54—56·9	—	—	1	—	1	2	2	7	13	8	7	6	2	—	4	1	—	1	—	—	—	—	55
57—59·9	—	—	—	—	—	2	3	2	11	7	12	7	11	—	2	—	—	—	1	2	—	1	61
60—62·9	—	—	—	—	2	—	1	2	12	6	7	—	5	—	4	5	—	—	—	—	—	—	44
63—65·9	1	—	—	—	—	—	—	3	4	2	11	5	4	—	4	1	—	—	—	—	—	—	35
66—68·9	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	1	—	1	—	—	—	—	5
69—71·9	—	—	—	—	—	—	—	2	—	4	2	4	4	—	2	—	—	1	—	—	—	1	20
72—74·9	—	—	—	—	—	—	—	—	1	1	—	5	1	1	—	—	—	—	—	—	—	—	9
75—77·9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
78—80·9	—	—	—	—	—	—	—	—	—	1	—	—	—	1	1	—	—	—	—	—	—	—	3
81—83·9	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1
84—86·9	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	2
87—89·9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
90—92·9	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	2
Totals	1	0	3	0	9	13	23	40	74	55	61	44	35	5	20	9	0	3	1	2	0	2	400

TABLE *AA* 5.

Series AA. Cross Homogamic Correlation. Length of A and Breadth of B.

Breadth of *B* in microns.

Length of *A* in microns.	27—29·9	30—32·9	33—35·9	36—38·9	39—41·9	42—44·9	45—47·9	48—50·9	51—53·9	54—56·9	57—59·9	60—62·9	63—65·9	66—68·9	69—71·9	72—74·9	75—77·9	78—80·9	81—83·9	84—86·9	87—89·9	90—92·9	Totals
160—169	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1
170—179	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	2
180—189	—	—	—	—	—	1	—	1	3	3	3	—	—	—	—	—	—	—	—	—	—	—	11
190—199	—	—	—	—	—	1	—	1	4	3	2	1	3	—	3	—	—	—	—	—	—	—	18
200—209	—	—	—	—	2	3	3	7	4	8	2	4	—	—	2	—	—	—	—	—	—	1	36
210—219	—	—	—	—	—	3	5	5	11	3	3	5	2	—	2	—	—	1	1	—	—	—	41
220—229	—	—	—	—	—	2	4	1	8	8	10	2	2	—	1	2	—	—	—	—	—	1	41
230—239	1	—	—	—	3	—	—	2	3	2	7	2	1	—	3	—	—	—	—	—	—	—	24
240—249	—	—	—	—	—	—	—	1	1	4	3	3	2	1	2	1	—	—	—	—	—	—	18
250—259	—	—	—	—	—	—	—	—	1	—	1	—	1	—	—	—	—	1	—	—	—	—	4
260—269	—	—	—	—	—	—	—	—	—	—	1	1	—	—	1	—	—	—	—	—	—	—	3
270—279	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
280—289	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
Totals	1	0	0	0	5	11	12	18	36	31	32	18	12	2	14	3	0	2	1	0	0	2	200

TABLE *AA* 6.

Series AA. Cross Homogamic Correlation. Length of B and Breadth of A.

Breadth of *A* in microns.

Length of *B* in microns.	*33—35·9*	*36—38·9*	*39—41·9*	*42—44·9*	*45—47·9*	*48—50·9*	*51—53·9*	*54—56·9*	*57—59·9*	*60—62·9*	*63—65·9*	*66—68·9*	*69—71·9*	*72—74·9*	*75—77·9*	*78—80·9*	*81—83·9*	*84—86·9*	Totals
160—169	—	—	—	—	1	—	1	—	—	1	—	—	—	—	—	—	—	—	3
170—179	—	—	—	—	—	—	—	1	2	—	—	—	—	—	—	—	—	—	3
180—189	1	—	—	1	—	—	1	1	—	—	—	—	—	—	—	—	—	—	4
190—199	1	—	1	—	—	1	7	2	1	3	1	—	1	—	—	—	—	—	18
200—209	—	—	3	—	5	3	7	7	10	6	10	—	—	1	—	—	—	1	53
210—219	—	—	—	—	3	8	9	4	6	4	2	1	—	2	—	1	—	1	41
220—229	—	—	—	—	—	4	5	2	2	6	4	—	2	2	—	—	—	—	27
230—239	1	—	—	—	2	3	6	4	3	2	2	1	—	1	—	—	—	—	25
240—249	—	—	—	1	—	2	—	2	2	1	3	—	2	—	—	—	—	—	13
250—259	—	—	—	—	—	—	2	1	2	2	1	1	—	—	—	—	—	—	9
260—269	—	—	—	—	—	1	—	—	1	1	—	—	1	—	—	—	—	—	4
Totals	3	0	4	2	11	22	38	24	29	26	23	3	6	6	0	1	0	2	200

THE ANTHROPOMETRIC CHARACTERISTICS OF THE INMATES OF ASYLUMS IN SCOTLAND.

BY J. F. TOCHER.

(1) *Introductory.*

THE idea of making anthropometric observations on the inmates of asylums in Scotland originated with Dr Macpherson, Commissioner in Lunacy. At his suggestion and through his instrumentality the survey was carried out by the writer and his assistants. The survey forms part of a scheme, entertained by the Henderson Trust of Edinburgh, and has for its aim the making of an anthropometric examination of the physical characters of the Scottish people. In view of the fact that the data could be very easily collected, it was considered advisable, in the first instance, to commence with the asylum class of the population. Measurements were therefore begun on the inmates in December 1903, and with the assistance and cooperation of the medical superintendents and staffs of the various asylums, were carried out and completed by the end of 1904. The data, collected and classified, have just been published by the Henderson Trust in the form of a Report, which is reprinted as a supplement to this Volume of Biometrika. This Report is intended by the Trust to be, and is, a repository of facts at the disposal of those who make a special study of the head form of Man, but it advances nothing whatever by way of interpretation of the facts themselves. Since the Henderson Trust is interested only in the collection of data, it is not by omission, but by design that the Trustees have, very properly, excluded from their Report any statements purporting to interpret the results or to reach general conclusions. That task is now attempted here. As the organiser of the survey and the person responsible for the Report, the writer has been accorded the first opportunity of making the necessary statistical analysis which must precede any interpretation of the data. The results of this analysis, together with a statement of such conclusions as have been reached, are embodied in the present memoir.

Altogether 4436 males and 3951 females were observed, but from these numbers 55 males and 26 females were excluded from the general analysis, because they were held to be exceptional cases by the medical superintendents under whose care they were. These persons were suffering from some congenital defect such as idiocy, or were rickety, syphilitic, or tuberculous, in such manner as directly to affect their anthropometric characters*. There were accordingly left 4381 males and 3925 females to represent the general lunatic population. Medical experts would no doubt agree that others might be excluded if a thorough knowledge of their history were available. It is therefore highly probable that an undetermined residue of exceptional cases remains. An elaborate investigation would, however, be required to reveal these cases, and as such an investigation was, under the circumstances, out of the question, and would affect the results of the present enquiry only in a very slight degree, the 4381 males and 3925 females are taken to represent substantially what may be termed the ordinary, normal asylum, or general insane population—i.e. those mentally affected, exclusive of the specific cases just mentioned. In view of the results of recent investigations by Pearl† and Blakeman‡ establishing a direct connection between age and certain physical characters, an analysis of the data in age groups would have been useful, and would have furnished valuable additional information in the comparative study of the inmates of individual asylums. Since the age range in the asylums is a pretty wide one, there is little doubt that our information as to the physical characters of the inmates would have been more complete had an age analysis been made. In recording the measurements at the asylums, however, no note was made, at the time, of the age of the inmates, and it was only when the statistical analysis was being carried out that the importance of separation in age groups was fully recognised. It was then found that considerable additional expense would have been incurred in furnishing an accurate statement of the ages of those observed, and any treatment of the data with respect to age groups was therefore abandoned. Since, however, none but adults are included in the analysis, any conclusions reached are those based on an adult population.

As explained in the Supplement§ and in the Henderson Trust Report‖, observations were made on a selection of both measurable and non-measurable characters of inmates. The measurable characters observed and recorded were those of stature (S), head length (L), head breadth (B), and head height (H); the non-measurable characters were those of hair colour, eye colour and nose contour. Head length was measured from the most prominent point of the glabella to the occipital point. L is therefore maximum head length. The head breadth measured was the maximum breadth above the level of the ear. Head height was taken from the mid points of the auricular passages to the vertex; in some respects, as will be seen from the analysis, this is a somewhat indefinite measurement. The hair categories were red (R), fair (F), medium (M), and dark (D). Red included light, bright and dark red; fair consisted of white, flaxen, and golden yellow; medium included chestnut and all shades of brown except dark brown and black. The eye categories were light, medium and dark. Light included light grey, blue or bluish grey. Dark embraced simply hazel brown and dark brown, while medium covered a mixed class (including grey) which were neither light nor dark. Hair if turned grey was not recorded. The nose shapes recognised and recorded were straight (S), Roman (R), Jewish (J), concave (C), and wavy (W).

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* All cases of idiocy when recognised *ab initio* were excluded, or if measured were afterwards excluded under this head.

† Pearl: *Biometrika*, Vol. IV. pp. 13—104.

‡ Blakeman: *Biometrika*, Vol. IV. pp. 124—160.

§ *Biometrika*, Vol. V. Suppl., p. 3.

‖ Henderson Trust Report, Vol. I. p. 14.

It seems desirable at the outset to state the problems which, from the nature of the data, it appears necessary to deal with.

(*a*) The fundamental problem clearly is: Does the insane population differ from the sane population? and this necessitates a comparison between sane Scots and insane Scots. No general comparison can, however, be made between these two classes since samples of the normal population in the various districts from which the insane population is drawn have not yet been measured. Only two or three short series are available for comparison. These will be dealt with under the districts to which they belong. Only pauper lunatics having been measured the population of each asylum is a local sample of the district served by that asylum.

(*b*) Do the data differ in the form of their distribution from data already collected from other, presumably sane populations?

(*c*) Do different parts of Scotland differ sensibly from each other, assuming the insane population to be an anthropometric sample of each local population?

(*d*) Is there any reason for supposing greater homogeneity or heterogeneity in one part of Scotland than in another?

(*e*) What general conclusions on other points may be drawn?

(2) *Relation between the Nature of the Distributions for Sane and Insane Populations. Problem (b).*

In this section it is proposed to consider, not the absolute values of the type, variation and correlation of characters, but the general question of how closely the *form* of the frequency distribution is the same for these two classes of the general population. This may be done (1) by discussing the frequency curve for the distribution of a single character, or (2) by considering the nature of the regression curve for two characters.

(i) *Distributions.* It has been shown by a number of writers (Fawcett*, Pearson and Lee†, Macdonell‡, and Pearl§), that, with short series, frequency curves for anthropometric characters such as stature, head measurements, cranial measurements and indices follow closely, but not without sensible exceptions, the normal or Gaussian curve. It becomes therefore a problem of much interest to determine

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[*] *Biometrika*, Vol. I. p. 443.

[†] *Biometrika*, Vol. II. pp. 361—369.

[‡] *Biometrika*, Vol. III. p. 227.

[§] *Biometrika*, Vol. IV. p. 40.

whether there are more marked deviations with long series generally, or in the case of the insane, from this form. In the latter case, such would probably arise if the bulk of the insane were characterised by two or more special head shapes; for example, if the insane had special tendencies to macrocephaly and microcephaly.

As stated in the introductory paragraph, certain individuals have been excluded from the general analysis, because they were considered by their medical attendants to have characters affected by special causes, not characteristic of insanity in general. The differences arising in the frequency distributions, according as these cases—throughout this memoir, termed exceptionals—are included or excluded, will now be noted. The constants have been calculated for the "entire insane" population—4436 males and 3951 females—and also for the "general insane" population, i.e. without the exceptionals—4381 males and 3925 females. The values of the constants are given in the following table (Table I.). They show that the distributions are more or less skew, and that when the "entire insane" population is considered, the extremes in the range affect the goodness of fit considerably—in other words, while the skew or normal curves fitted to the distributions fairly describe their nature when considered as a whole, the most important contributions to defect of fit arise from the "tails." Even the "general insane" population shows for most characters excess frequency at the tails, indicating the probability that the homogeneity of the series is affected by the "undetermined residue" referred to above.

Considering the "entire insane" population first, we see that (*a*) the skewness measured by χ is probably significant in all cases since it amounts in each case to three, or more, times the probable error, (*b*) the kurtosis, η, is in all cases significant, amounting in every case to many times the probable error. In all the distributions, the positive values of η indicate leptokurtic curves, their magnitudes very largely depending on outlying observations, as will presently be seen[*]. Thus the skewness and leptokurtosis so affect the distributions that their frequencies cannot be represented by normal curves. Considering further the "entire insane" population, we see that κ_2 lies between 0 and 1 and therefore Type IV. is the actual form needed, but since κ_2 is in every case very small it is clear[†] that the distributions will, if β_1 be very small and β_2 differ in excess significantly from 3, approach closely to Type IV. with symmetry[‡]. This actually occurs for all characters but stature, β_1 being less than ·03 in all cases except one ($H\male$) when it is only ·1 and $\beta_2 = 3 + \eta$, differing very sensibly from 3. Thus it is seen that the "entire insane" population approaches to symmetry[§] in distribution of head characters, and the deviation from normal frequency, accordingly, is not

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[*] In 10 out of 24 cases, C. D. Fawcett's series shows leptokurtosis, while Macdonell's English series shows 14 cases of leptokurtosis out of 26. *Biometrika*, Vol. I. p. 442, Vol. III. p. 228.

[†] Pearson: *Phil. Trans.* A. Vol. 197, pp. 443—459.

[‡] That is to the form: $y = y_2 [1 + x^2/\{2\sigma^2 (m_2 - \frac{1}{2})\}]^{-(m_2+1)}$, where $\beta_2 - 3 = 6/(2m_2 - 3)$. Professor Pearson points out to me that there is an unfortunate interchange of m_1 and m_2 in the memoir, lines 2, 3, 4 and 5 from bottom. *Biometrika*, Vol. IV. p. 174.

[§] Not absolute symmetry, because the values of β_1, although small, do differ sensibly from zero.

TABLE I.

Analytical Constants of Curves.

"Entire Insane" Population.

Character	No.	Unit	μ_2	μ_3	μ_4	β_1	$\sqrt{\beta_1}$	η	κ_1	κ_2	Mean	Mode	d	χ	$\frac{\eta}{E_\eta}$	$\frac{\chi}{E_\chi}$	$\frac{\beta_1}{\eta}$
L ♂	4436	3 mm.	5·1026	−1·2422	97·8150	·0116	·1078	·7568	1·4787	·0060	195·4556	195·7096	−·0847	−·0375	15·2515	−3·0215	·0154
B ♂	4436	2 mm.	7·6446	−2·4439	211·0586	·0134	·1156	·6116	1·1830	·0086	151·5005	151·7359	−·1177	−·0426	12·3249	−3·4322	·0219
H ♂	4436	2 mm.	8·5648	7·9651	278·0116	·1010	·3178	·7899	1·2769	·0613	136·7322	136·0561	·3379	·1155	15·9187	9·3078	·1278
S ♂	4401	2 in.	2·1001	−1·5952	21·2949	·2747	·5241	·8283	2·8324	·0804	65·6712	66·1119	−·2203	−·1521	16·6303	−12·2122	·3317
L ♀	3951	3 mm.	4·3181	−1·3302	72·9486	·0220	·1483	·9123	1·7586	·0958	186·3743	186·6806	−·1021	−·0491	17·3583	−3·7376	·0241
B ♀	3951	3 mm.	2·8133	−·6006	29·6032	·0162	·1273	·7404	1·4321	·0086	145·1985	145·4232	−·0749	−·0447	14·0817	−3·3981	·0219
H ♀	3951	2 mm.	7·6607	3·0927	197·4970	·0213	·1459	·3653	·6668	·0241	130·9579	130·6240	·1669	·0603	6·9490	4·5872	·0583
S ♀	3915	2 in.	1·8525	−1·0182	17·5026	·1631	·4038	2·1000	3·7108	·0362	60·8983	61·1852	−·1434	−·1054	39·7930	−7·9097	·0777

"General Insane" Population.

Character	No.	Unit	μ_2	μ_3	μ_4	β_1	$\sqrt{\beta_1}$	η	κ_1	κ_2	Mean	Mode	d	χ	$\frac{\eta}{E_\eta}$	$\frac{\chi}{E_\chi}$	$\frac{\beta_1}{\eta}$
L ♂	4381	3 mm.	4·7728	−·9076	71·3461	·0076	·0871	·1320	·2413	·0236	195·4405	195·7049	−·0881	−·0404	2·6450	−3·2336	·0574
B ♂	4381	2 mm.	7·2031	−1·4256	167·2315	·0054	·0738	·2231	·4299	·0952	151·5037	151·6776	−·0869	−·0324	4·4686	−2·5960	·0244
H ♂	4381	2 mm.	7·8103	5·4408	214·9607	·0621	·2493	·5240	·8615	·0552	136·6641	136·1130	·2756	·0986	10·4953	7·9023	·1186
L ♀	3925	3 mm.	4·0973	·1049	52·6389	·0002	·0127	·1355	·2705	·0004	186·4436	186·4083	·0118	·0058	2·5694	·4403	·0012
B ♀	3925	3 mm.	2·6905	·0089	24·3749	·0000	·0020	·3672	·7344	·0000	145·2566	145·2526	·0013	·0008	6·9623	·0608	·0000
H ♀	3925	2 mm.	7·3318	3·9643	164·9277	·0399	·1997	·0682	·0167	1·8132	130·9935	130·4558	·2689	·0993	1·2928	7·5301	·5852

in the main produced by a heterogeneity depending solely on the presence of a macrocephalic or of a microcephalic group alone. In the case of stature, the values of β_1 are considerably larger. The skewness of the distribution is more marked and is largely due in the case of females, and to some extent in the case of males, to the existence of a dwarf element in the "entire insane" population. This element in the females is in the main identical with the group termed "exceptionals," removed from the "entire insane" population in the manner already explained.

Some peculiarities of the "exceptionals" deserve to be noted. Among the males the head height of the group is much greater than that of the "general insane" population—in other words the male "exceptionals" are a hypsicranial group. The female "exceptionals" are small sized generally; in all characters the means are significantly less than the "general insane" population. The variability of the "exceptionals" for all head characters and for stature is very great indeed and is found to be due to excess frequencies on both sides of the range and a corresponding defect in the frequencies about the mean. The exceptionals are thus mainly a mixture of two groups, one, larger sized in all characters—a megameric group, and another smaller sized in all characters—a micromeric group. An inspection of the following table (Table II.) will serve to emphasize these points.

TABLE II.

Character	"Entire Insane" Population		"General Insane" Population		Exceptionals	
	Mean	S. D.	Mean	S. D.	Mean	S. D.
L ♂ ...	195·5	6·78	195·5	6·55	196·7	16·37
B ♂ ...	151·5	5·53	151·5	5·39	151·7	13·42
H ♂ ...	136·7	5·85	136·7	5·58	147·2	20·75
S ♂ ...	65·7	2·90	65·9	2·84	65·4	4·22
L ♀ ...	186·4	6·23	186·5	6·04	176·5	10·97
B ♀ ...	145·2	5·03	145·3	4·91	142·9	13·17
H ♀ ...	131·0	5·54	131·0	5·43	125·3	14·62
S ♀ ...	60·9	2·72	61·2	2·58	58·4	5·77

The mean is less than the mode for all characters except auricular height, ♂ and ♀, in which cases it is sensibly greater. Since the "general insane" population forms a pretty long series, one can hardly compare the asymmetry values with those of the very much shorter series of Fawcett and others, since the probable errors in these latter cases are relatively very large. Four long series from general sane populations are however available for stature: (α) Baxter's American recruits*, (β) Powys's New South Wales observations†, (γ) Weldon's Verona statistics‡ (Italian conscripts and recruits), and (δ) Macdonell's 3000 English criminals. One long series is available for L and B, viz. Macdonell's criminals. In the case of the 25,878 American recruits there is a very distinct positive asymmetry (·038 ± ·004) accompanied by mesokurtosis. The New South Wales males show quite significant negative asymmetry for the age groups 25—30 and 60 and over, perhaps significant negative asymmetry for the 40—50 and 50—60 groups, while the 20—25 and 30—40 groups are not significant although still negative. Mr Powys while noting that, for each group, $M_e < M_o$, observes that the skewness in all cases is small, but relatively this is not so, for at least the 25—30 and 60 upwards groups. The Italian conscripts and recruits both show very significant negative asymmetry, agreeing with the New South Wales males and the Scottish "general insane" population. The conscripts show very marked leptokurtosis, and the recruits significant platykurtosis. For four long series, then, viz. New South Wales males, Italian conscripts, Italian recruits and the Scottish general insane population, there is agreement as to asymmetry—in all four cases it is significantly negative; in one case, the American recruits, there is quite significant positive asymmetry. In two cases of very long series there is relative symmetry, viz. 15,117 N. S. W. males (30—40), and 5442 N. S. W. males (20—25) group. Macdonell's 3000 English criminals show slight negative asymmetry. Thus it is seen that in these long series of stature distributions, considered without reference to the ages of the adults in the populations measured, there is significant asymmetry in all cases except one; in three cases it is negative, in one only is it positive. It falls finally to be noted therefore that the negative asymmetry in stature of the "general insane" population is not specially characteristic of the insane; it is also a characteristic of some sane populations. As already stated, no very long series of head measurements are available for comparison with the exception of the 3000 English criminals, the skew curve of B for the series being given by Macdonell*. Here again negative asymmetry is found, and since the ratio $\frac{\chi}{E_\chi} = 3{\cdot}34$, the deviation from symmetry is probably significant. The L distribution of the same series also shows distinct negative asymmetry, the ratio $\frac{\chi}{E_\chi} = 3{\cdot}40$ being found by the writer from the figures kindly supplied by Dr Macdonell. *Thus in L and B, just as in stature, when long series are pitted against long series, there is agreement as to the nature of the distribution, which seems to be in the direction of negative asymmetry. The rule, therefore, as stated by Fawcett†, Macdonell‡ and Pearl§ for short series of distributions of anthropometric characters does not appear to hold for long series.*

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* Pearson: *Phil. Trans.* Vol. 186 A, p. 385.

† Powys: *Biometrika*, Vol. I. pp. 43—46.

‡ Pearson: *Biometrika*, Vol. IV. p. 506.

For L and H, except the above case for L, only short series are at present available, and since there is no definite deviation in one direction more than another for these (Macdonell's English Crania, Fawcett's Naqada Crania, etc.), and since the probable errors are large, no comparison can profitably be instituted between them and the long Scottish series.

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* Macdonell: *Biometrika*, Vol. I. p. 183.

† Fawcett: *Biometrika*, Vol. I. p. 443.

‡ Macdonell: *Biometrika*, Vol. III. p. 227.

§ Pearl: *Biometrika*, Vol. IV. p. 40.

The general "goodness of fit" of skew and normal curves for the "entire insane" population may next be considered. Taking first the normal curves, we find that in every case the fit is extremely bad; the skew curves show fairly good fits for head breadth (♂ and ♀), tolerable perhaps for *H* (♂ and ♀) and bad for stature and *L* (♂ and ♀). If now the values for the "general insane" population are examined, it is found that the fit of normal curves is very bad for stature and *H* (♂ and ♀), poor for *B*, and tolerable only for *L*. It must therefore be concluded that the rejection of the medically defined exceptionals does not convert the distributions into good normal curves. This can be seen from Table I., where the analytical constants are calculated for the "general insane" population. It is found that (i) the skewness still remains significant for *L* (♂), *H* (♂) and *H* (♀) and perhaps for *B* (♂), (ii) the leptokurtosis is still significant for *B* (♂ and ♀), *H* (♂) and possibly for *L* (♂ and ♀). Summarising, good normal fits are not obtained for the "entire insane" population whether "general goodness of fit" is considered as in Table III., or the values of the analytical constants as in Table I.

TABLE III.

Goodness of Fit. Entire Insane Population. Summary of Tests.

1	2	3	4	5	6	7	8	9	10
Character	Sex	Unit	Number	No. of individuals especially affecting Fit	Percentage especially affecting Fit	$\left[x=\frac{X-M}{\sigma}\right]^*$ Points affected x axis	Nature of Curve fitted	χ^2	P
L ...	♂	3 mm.	4436	5	·11	−4·79 +4·95	Type IV	67·75	Very Small
B ...	♂	2 mm.	4436	23	·52	−2·53 to −4·34 +4·34	,,	26·60	·304
H ...	♂	2 mm.	4436	18	·41	−3·29 + 2·87	,,	35·20	·110
S ...	♂	2 in.	4401	73	1·66	−5·75 +1·84 to + 3·22	,,	65·90	Very Small
L ...	♀	3 mm.	3951	25	·63	−5·67 +2·03	,,	54·10	,,
B ...	♀	3 mm.	3951	3	·08	−4·41	,,	18·80	·328
H ...	♀	2 mm.	3951	7	·18	−2·79 to −3·88	,,	32·10	·115
S ...	♀	2 in.	3915	93	2·38	−1·43 to −4·37 +2·24	,,	68·50	Very Small
L ...	♂	3 mm.	4381	10	·23	−3·12 to −4·03	Normal	22·10	·140
B ...	♂	2 mm.	4381	8	·18	−3·36	,,	39·10	Small
H ...	♂	2 mm.	4381	42	·96	+2·30 to +3·73	,,	84·20	Very Small
S ...	♂	2 in.	4393	38	·87	−3·13 to −4·54	,,	495·80	,,
L ...	♀	3 mm.	3925	29	·74	−1·89	,,	23·50	·170
B ...	♀	3 mm.	3925	15	·38	−3·30 + 3·40	,,	43·00	Small
H ...	♀	2 mm.	3925	37	·94	−2·49 & −3·23 +2·68 & +3·42	,,	54·40	Very Small
S ...	♀	2 in.	3890	20	·52	−3·17 & −3·94 +3·81 & +4·58	,,	325·50	,,

* M = Mean. X = Absolute magnitude of character. Relative scale is $\frac{X-M}{\sigma}$.

The removal of medically defined "exceptionals" tends to improve the goodness of a normal distribution, but it is far from making it essentially good.

On the other hand the only test made of the goodness of fit of skew curves for the "general insane" population is in the case of L (♂), and this gives $P = \cdot 88$, a splendid fit as compared with the $P = \cdot 14$ of the corresponding normal fit, or the practical impossibility of fit at all for the "entire insane" population before the "exceptionals" are removed. It seems likely therefore that the skew curves would describe the "general insane" population satisfactorily in these cases where the normal curve fails. This is a case again of close approximation to symmetry, differing to some extent from normality. But until long series of sane populations are measured it cannot be said that in the "general insane" population there is a wider deviation from the normal curve than occurs in samples of the "general sane" population.

It seems desirable to notice more specially the H distributions, the physical constants of which indicate a wider deviation from the normal curve than exists in either of the two characters L and B. Dealing firstly with H♂, we find that, while the values of β_1, β_2, κ_1 and κ_2 are less than for the whole series (κ_2 still indicating Type IV.) significant leptokurtosis is associated with significant asymmetry, and that, owing to the emphasis on the positive side of the range between 2·30 to 3·73 on the relative scale, the normal curve fails to fit the distribution. The distribution of H♀ shows a different type of curve from the one deduced for the "entire insane" population. The value of κ_2 being > 1 (1·813) a curve of Type VI. is indicated. A 5 mm. grouping however gives $\kappa_2 = \cdot 8$, indicating Type IV. Mesokurtosis occurs with significant asymmetry, and, compared with the normal curve, there is emphasis on both sides of the range. The emphasis occurs at the points 2·49 and 3·23 on the negative, and 2·68 and 3·42 on the positive side of the relative scale. Since the skewness in the character H is certainly significant, both in males and females, since a relatively greater proportion affects the goodness of fit of the normal curve, and since H shows greater relative variability it is evident that this character differs somewhat from L and B in the nature of its distribution. Here, however, the character head height, as defined in the first part of this memoir, must be considered.

It should be noted that the character H in the living head, as measured from the mid points of the ear passages to the vertex, cannot properly be compared with any of the three similar measurements on the skull, even after due allowance is made for scalp-depth. These three measurements are as follows:

(1) Basi-vertical height, i.e. height of skull, from the basion to the point on the top of the skull vertically above it, perpendicular to the horizontal plane of the Frankfurt Concordat—the German horizontal plane. This plane is determined by three points, the two highest points on the upper rims of the auricular passages and the lowest point on the under rim of the left eye socket.

(2) Auricular height, i.e. the vertical height of the skull measured perpendicular to the German horizontal plane, in a line perpendicular to the auricular

axis round which the skull swings when suspended from the uppermost points of the upper rims of the auricular orifices. This height is taken by some to the bregma.

(3) Basi-bregmatic height, i.e. the height of the skull measured from the basion to the bregma.

In (1) and (2) the highest point in the vault of the skull is determined by the German plane, and therefore these measurements may not be quite so satisfactory as (3), the basion and the bregma being two fairly definite anatomical positions. But in the living head, the conditions of (1), (2), and (3) are never reached. The centre or mid points of the ear holes are not positions so definitely ascertained as the uppermost position on the temporal bone of the external auditory canal, as indicated by the suspension of a skull on two pointers. The soft tissue of the ear yields readily to the slightest pressure, and, therefore, with an instrument having blunt or spherical ends for the ear passages, the greatest care must be exercised in order to avoid drawing the ear up. Any error arising through this however in the asylum survey would be small, as the greatest care was exercised in determining the position. Probably the error is small also at the upper limit, although with the greatest care, one cannot expect the same precision as is obtainable with length and breadth, when it is remembered that the upper limit is "the top of the head, measured in a vertical plane when the eyes are directed to the horizon." What seem more important and real are the thickness of the scalp, the hair, and the slight variations in the pressure on the instrument. Thus it is difficult to say whether the positive skewness in the distribution of head heights is due severally or jointly to (1) nature of the measurement, (2) nature of the instrument, and (3) to the observer, or (4) whether the positive skewness belongs to the character itself and is really in the nature of its distribution.

To summarise, it is clear that the distributions of the various characters, whether the "entire insane" or the "general insane" population is considered, may be described with fair accuracy by skew curves, with the exception of *L* (♂ and ♀ "general insane") which may be fairly described by the normal curve. (See Diagrams I. to VII.)

Further, it has just been shown that for long series, just as great divergencies from normality as exist among the "general insane," occur among the sane population, although greater divergencies are shown when the "entire insane" population is considered. It is *not*, however, established that there is not a difference in the form of distribution between the sane and the "general insane." So far as Scotland is concerned this cannot be definitely determined until a corresponding general survey is carried out. This analysis and discussion thereon merely show that when long series are pitted against long series, quite as great a divergence from normality, as measured by the kurtosis and asymmetry, occurs among the sane as among the insane. The question whether there is really a difference in the form of distribution between the sane and insane must be left an open one when it is remembered that, after the striking "exceptionals" are

Diagram I. Head Length.—4436 Males.

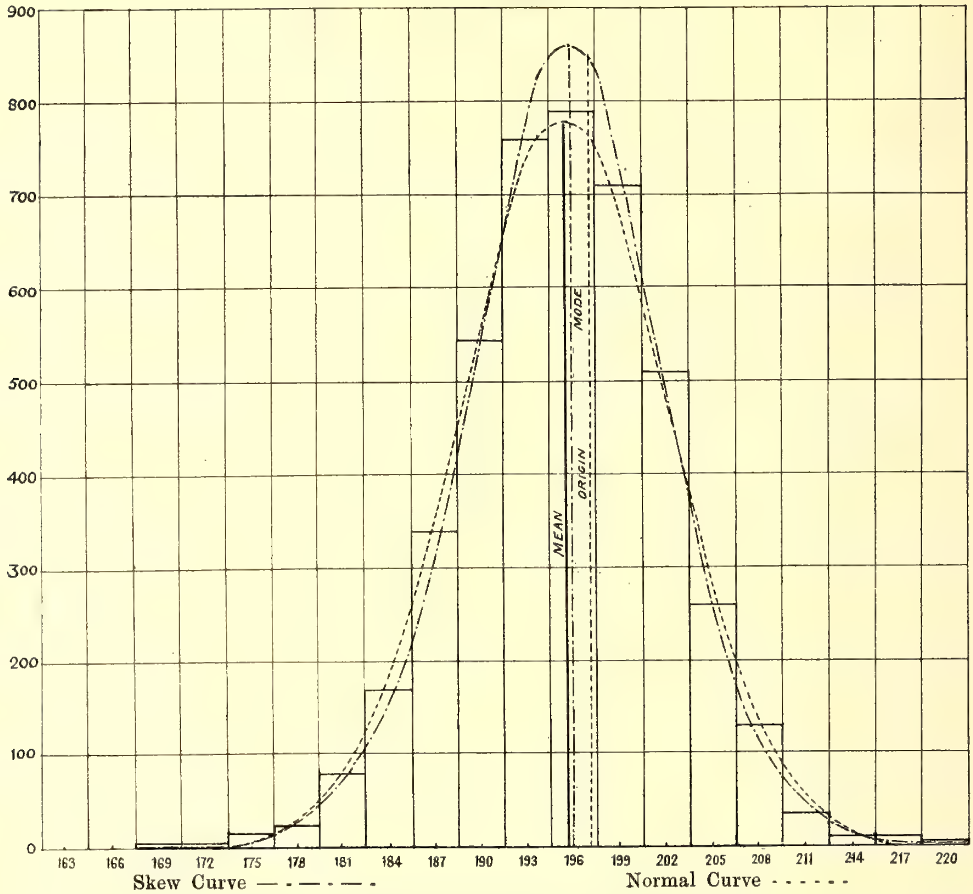


Diagram II. Head Length.—Skew Curve.—4381 Males.

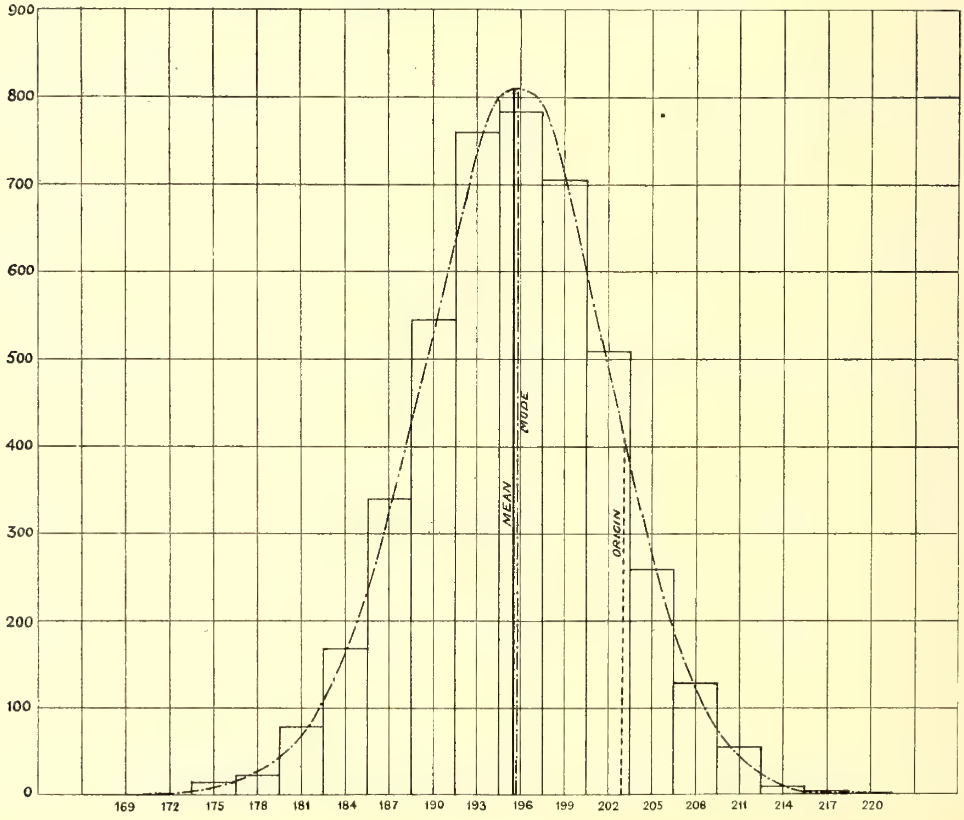


DIAGRAM III. Head Height.—4436 Males.

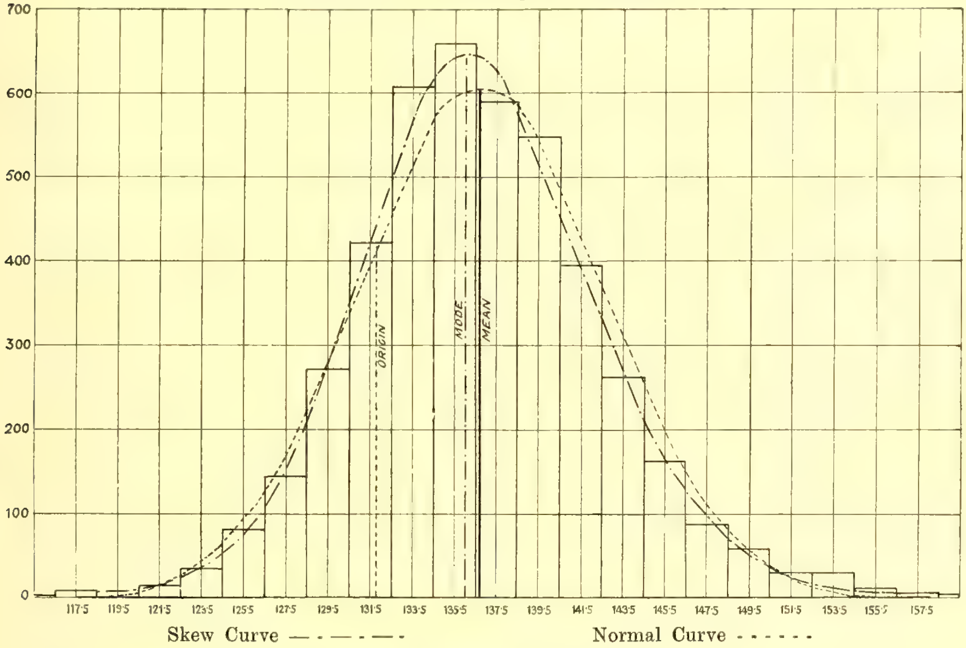


DIAGRAM IV. Stature.—4401 Males.

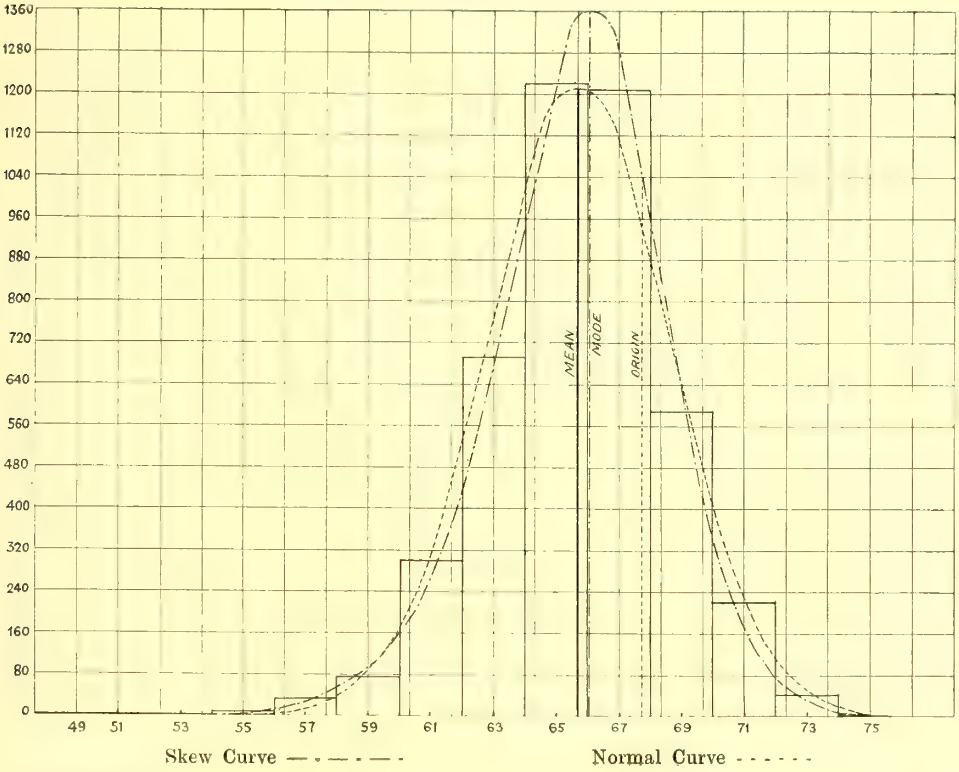


Diagram V. Head Breadth.—3951 Females.

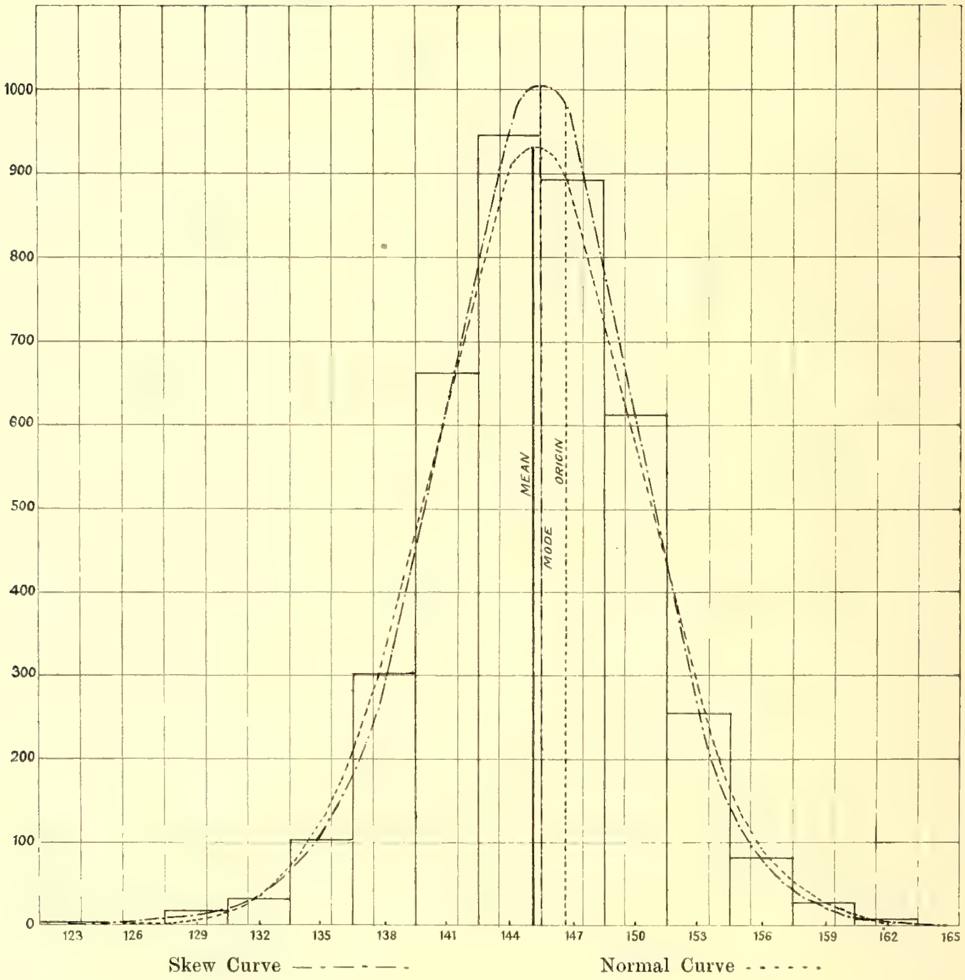


Diagram VI. Head Height.—3951 Females.

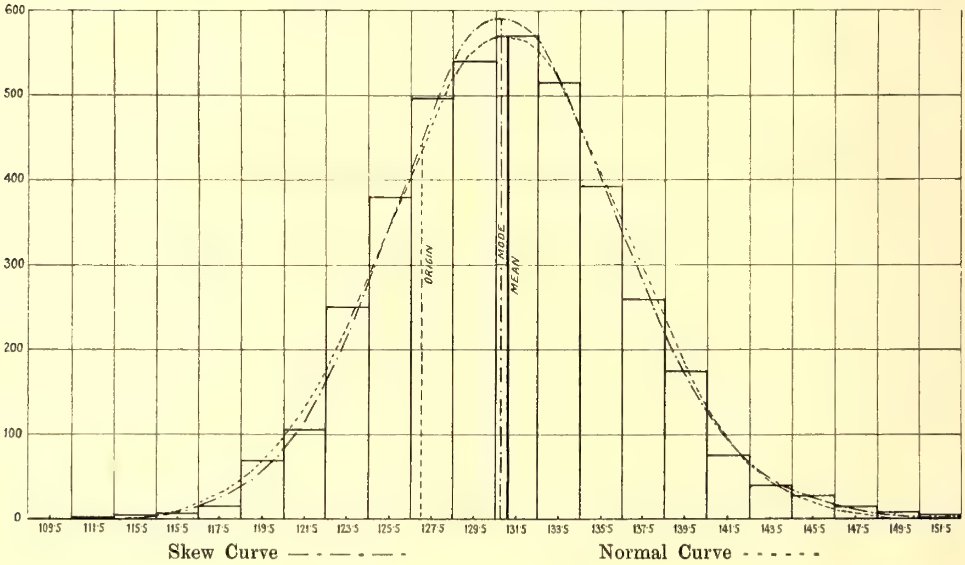
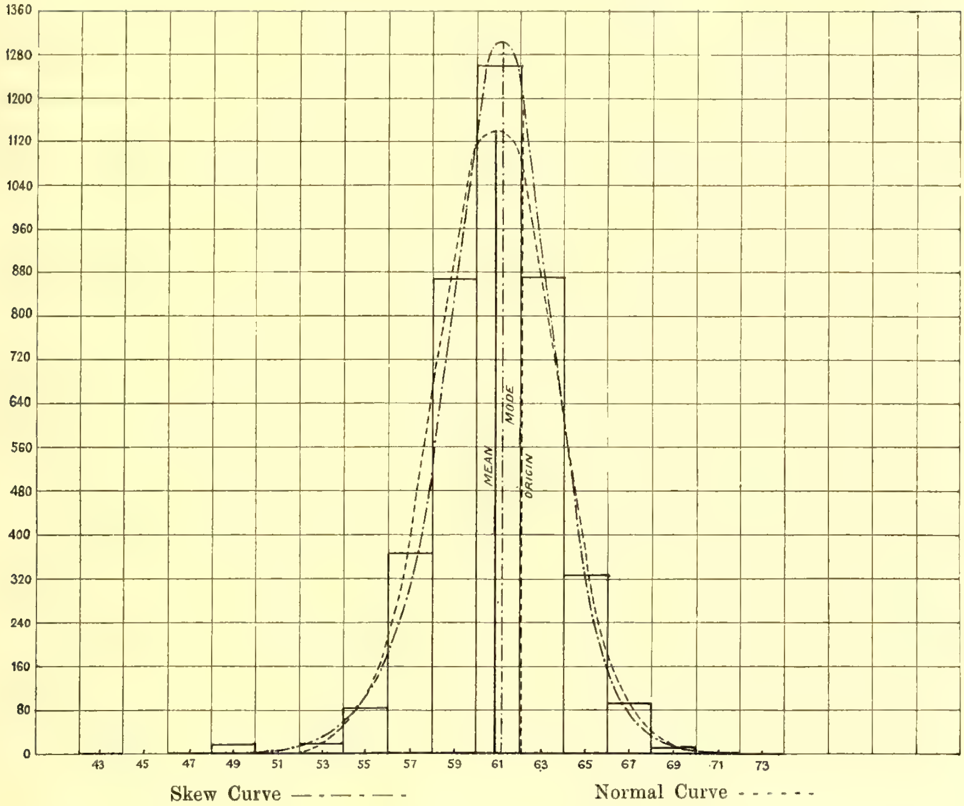


Diagram VII. Stature.—3915 Females.



removed for the reasons given above, it cannot be said whether others should or should not be removed by a similar process of reasoning. Heterogeneity, however, may exist. If, for instance, local groups at each individual asylum are taken and their degrees of goodness of fit to the normal curve tested, it is found that, with a 5 mm. grouping, this curve gives very good fits in 125 cases out of 176 (see Table IV.). This, indeed, shows no more than that, for small samples of the insane, the normal curve describes the distribution within the probable errors of the constants, exactly as Fawcett, Macdonell, and others have shown for small cranial series. The divergence from normality in both the "entire insane" and the "general insane" populations of Scotland is therefore either (*a*) *real* because the greater numbers allow of more accurate determinations of the kurtosis and asymmetry constants, or (*b*) *spurious* and due to the introduction of local heterogeneity. The evidence for and against heterogeneity will presently be considered.

(ii) *Correlations.* The correlations and the nature of the regression curves for two characters will now be briefly considered. The first main point to be noted is that the values of the coefficients for the "entire insane" population are uniformly greater than those of the "general insane." This is chiefly due to the

TABLE IV.

Goodness of Fit. Normal Curve. Individual Asylums.

Value of P.

(For 5 mm. grouping.)

	L		*B*		*H*		*S*	
	Males	Females	Males	Females	Males	Females	Males	Females
Aberdeen	·916	·042	·911	·164	·171	·184	·831	·350
Dumfries	·815	·797	·850	·281	·869	·372	·915	·782
Dundee	·942	·797	·893	·636	·920	·447	·730	·995
Edinburgh ...	·986	·880	·311	·221	·995	·934	·219	·341
Montrose	·770	·973	·886	·660	·925	·606	·610	·860
Argyll	·758	·238	·273	·663	·042	·864	·756	·834
Ayr	·778	·834	·822	·506	·730	·180	·885	·782
Banff	·998	·768	·645	·860	·044	·822	·977	·584
Elgin	·899	·954	·588	·255	·807	·732	·062	·413
Fife	·925	·983	·516	·600	·016	·296	·188	·756
Glasgow (Gartloch)	·629	·091	·107	·234	·516	·953	·624	·612
„ (Lenzie)	·678	·719	·570	·304	·144	·195	·021	·183
Govan	·249	·444	·819	·403	·098	·382	·022	·875
Haddington ...	·720	·881	·136	·801	·954	·991	·612	·296
Inverness	·391	·943	·526	·963	·085	·900	·030	·333
Lanark	·163	·277	·948	·658	·825	·169	·597	·056
Midlothian ...	·690	·749	·939	·277	·885	·779	·782	·331
Perth	·752	·834	·072	·822	·214	·730	·612	·842
Roxburgh ...	·438	·680	·995	·139	·617	·837	·952	·544
Stirling	·885	·636	·903	·953	·701	·537	·811	·423
Greenock	·933	·972	·964	·684	·429	·901	·189	·393
Paisley	·639	·420	·986	·576	·343	·451	·875	·959
Number of very good fits ...	19	18	17	14	13	15	15	14

"exceptionals" which are mostly "outliers" in the tables of pairs of distributions considered. The second main point to be noted is that the values for males and females are approximately equal and do not diverge to the extent shown in the values of the corresponding coefficients in most other published results. In the "entire insane" series the most highly correlated pair of characters is that of *L* & *B*, and then follow *L* & *H*, *B* & *H*, *L* & *S*, *H* & *S*, and *B* & *S*. The greatest divergence between the values of the coefficients for males and females appears in the case of the pair of characters *L*, *S*, the difference being ·3284 − ·2573 = ·0711. There is closer agreement in the "general insane" series, the greatest difference, ·0355, between the values for males and females occurring in the case of the pair of characters *L*, *H*.

The reader will find in Table V. a summary of the coefficients evaluated while the lines of regression of head length on stature, ♀, and head breadth on head length, ♂, are shown in Diagrams VIII. and IX. It will be seen from Table VII. that, taking head measurements,—to be directly comparable—there is a higher

DIAGRAM VIII. Line of Regression; Head Length on Stature. 3915 Females. Mean Length 186·42 mm. Mean Stature 60·9 in.

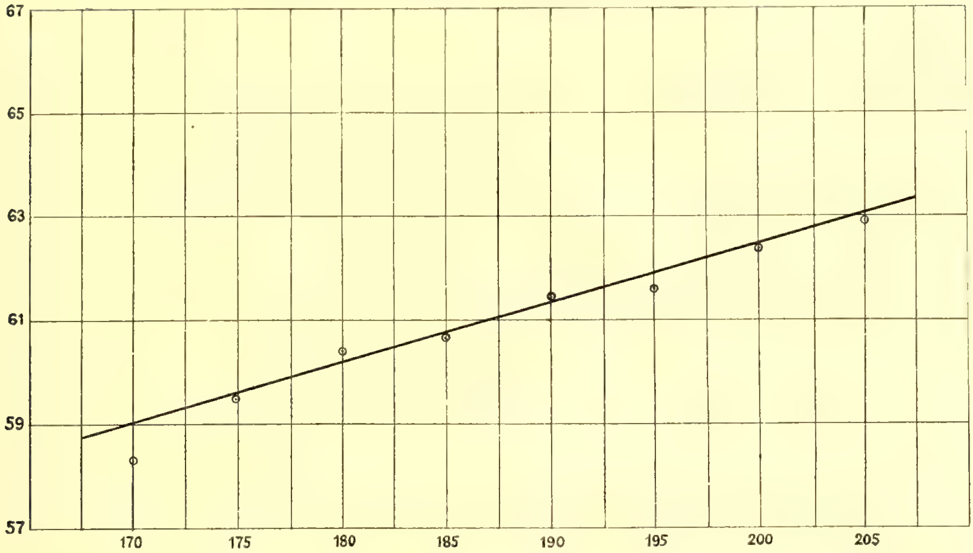
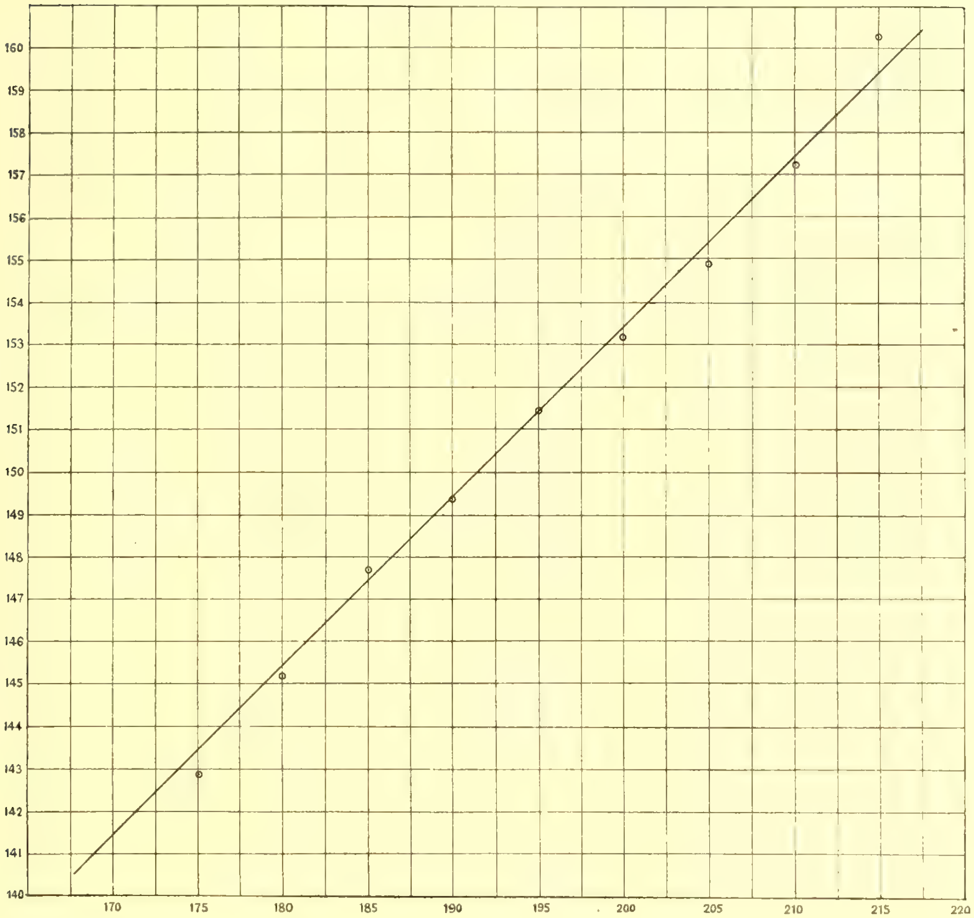


DIAGRAM IX. Line of Regression; Head Breadth on Head Length.—4381 Males. Mean Length 195·47. Mean Breadth 151·53.



degree of correlation in the pair of characters L, B among the "general insane" than among the 3000 English criminals or the 1000 middle class English, which show the lowest degree of the three classes. For the pair LS the values are very similar for "Entire Insane" males and English Criminals. The values of the corresponding coefficients for some series of skull measurements are given in the table. They show marked differences from the series of head measurements.

TABLE V.

Coefficients of Correlation.

"Entire Insane" Population	4436 Males	3951 Females
Head Length and Breadth	·5026 ± ·0076	·5235 ± ·0078
Head Length and Height	·4027 ± ·0085	·3566 ± ·0094
Head Breadth and Height	·3761 ± ·0088	·3474 ± ·0095
Head Length and Stature*	·3284 ± ·0091	·2573 ± ·0101
Head Breadth and Stature*	·2002 ± ·0098	·2211 ± ·0103
Head Height and Stature*	·2340 ± ·0096	·2357 ± ·0102
"General Insane" Population	**4381 Males**	**3925 Females**
Head Length and Head Breadth	·4848 ± ·0079	·4672 ± ·0084
Head Length and Head Height	·3755 ± ·0089	·3420 ± ·0095
Head Breadth and Head Height	·3529 ± ·0090	·3325 ± ·0096

In Table VI. are given the values of the correlation ratio, η, and also their differences from the corresponding *comparable* values of r, (i.e. those found without

TABLE VI.

Test of Linearity of Regression.

"General Insane" Population.

Males	η	r	$\eta - r$	$\frac{\sqrt{N}}{\cdot 67449} \cdot \frac{1}{2}\sqrt{\eta^2 - r^2}$†
Head Length and Breadth	·4612	·4573	·0039	2·94
Head Length and Height	·3547	·3546	·0001	·41
Head Breadth and Height	·3390	·3299	·0091	3·83
Head Length and Stature	·3226	·3133	·0093	3·78
Females				
Head Length and Breadth	·4372	·4358	·0014	1·62
Head Length and Height	·3241	·3216	·0025	1·94
Head Breadth and Height	·3109	·3084	·0025	1·82
Head Length and Stature	·2489	·2488	·0001	·17

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* 4401 Males and 3915 Females.

† Since $(\eta - r)/r$ is small this formula gives a good arithmetical approximation to the value of $(\eta - r)/E$. See *Biometrika*, Vol. IV. pp. 348, 349. Blakeman on "Linearity of Regression."

applying Sheppard's correction to the moment μ_2, the square of each standard deviation involved in the calculation) both absolute, and relative to $E_{\eta-r}$. Although the absolute differences appear small they are relatively large in three cases, *LB* ♂, *BH* ♂, and *LS* ♂. In all the other cases the relative differences are small and are not significant—the regression is truly linear. It would thus appear that, in the case of the males, there is a probable significant departure from linearity in the regression curves of these three pairs of characters among the "general insane" population. On plotting linear regression curves, it is seen that this departure from linearity is mainly but not altogether caused by numerically small groups at the ends of the regression lines. (See Diagram IX.) The non-linearity however is not so very great and it seems scarcely worth while undertaking the statistical labour of fitting skew regression curves to the results. For comparative purposes, the correlation coefficients in the case of *L* & *B* ♂ was determined by three different methods with the following result:

	Ordinary method.	θ method*.	Contingency method †.
r	·5026	·5010	·5019.

(3) *Means and their Differences. Problem* (*c*).

In this section the following problem is considered: Do different parts of Scotland differ sensibly from each other, assuming the "general insane" population to be an anthropometric sample of each local population? This problem can be answered by discussing the individual asylum means and the extent of the difference of each from the remainder of the "general insane" population. Asylum means, no matter what character be selected, show differences as we pass from asylum to asylum. Tables XV. to XXI. of Supplement‡ give the values of the means of all the characters measured for each asylum, the general mean being the last line on every table. The probable errors are given in every case, but in order to note whether or not individual asylum means differ significantly from the means of the remainder of the "general insane" population, the differences have to be studied with respect to the standard deviation of sampling of these differences. If $m =$ the mean of any character at any one of the asylums and $M' =$ the mean of the same character for the remainder of the asylum population, $m - M'$ is the difference between the local mean and that of the rest of the same population. Then, if $\sigma =$ standard deviation of any character at any one of the asylums and $\Sigma' =$ standard deviation of the same character for the remainder of the population,

$$\left(\frac{\sigma^2}{n} + \frac{\Sigma'^2}{N'}\right)^{\frac{1}{2}}$$

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* Using fourfold table. See Pearson, *Phil. Trans.* Vol. 195 A, pp. 1—47, 79—150.

† See *Drapers' Company Research Memoirs*, *Biometric Series* I, on "The Theory of Contingency, &c." K. Pearson.

‡ *Biometrika*, Vol. v. Supplement, pp. 92—96.

(where n = number of inmates at any asylum and N' = the remainder of the population of inmates) is the standard deviation of sampling of $m - M'$. This is the well-known expression for the standard deviation of the differences of two means, and the ratio

$$(m - M') \bigg/ \left(\frac{\sigma^2}{n} + \frac{\Sigma'^2}{N'}\right)^{\frac{1}{2}}$$

is a measure of the deviation of the local means from the mean of the rest of the population relative to the standard deviation of sampling, or, shortly, is the relative local difference $(RLD)_m$ expressed in a way enabling its significance to be tested. Professor Pearson, whose many suggestions in the course of this investigation the writer desires here gratefully to acknowledge, points out that the biometrician is not warranted in using the ratio

$$(m - M) \bigg/ \left(\frac{\sigma^2}{n} + \frac{\Sigma^2}{N}\right)^{\frac{1}{2}}$$

where M = general mean, and Σ = standard deviation for the whole population, N, (although this is sometimes done), since the local sample is included in the determination of mean and standard deviation of the general population. In a note* kindly shown to the writer Professor Pearson shows that

$$(m - M') \bigg/ \left(\frac{\sigma^2}{n} + \frac{\Sigma'^2}{N'}\right)^{\frac{1}{2}} = (m - M) \bigg/ \left[\frac{\Sigma^2}{N} + \frac{\sigma^2}{n}\left(1 - \frac{2n}{N}\right) - \frac{n\,(M - m)^2}{N\,(N - n)}\right]^{\frac{1}{2}},$$

and is true whatever the magnitudes of N and n may be. In the present series where $N = 4381$ and 3925 for males and females respectively, the term $\frac{n\,(M - m)^2}{N\,(N - n)}$ becomes small and may be neglected, so that the standard deviation of sampling of $m - M'$ is given by (and can be conveniently calculated by using) the expression

$$\sqrt{\frac{\Sigma^2}{N} + \frac{\sigma^2}{n}\left(1 - \frac{2n}{N}\right)},$$

and the ratio applicable to the present data is thus

$$(m - M) \bigg/ \sqrt{\frac{\Sigma^2}{N} + \frac{\sigma^2}{n}\left(1 - \frac{2n}{N}\right)}.$$

The values of this ratio, if the samples are purely random ones, are simply the abscissal values of the normal curve whose equation is $y = 1/\sqrt{2\pi} \,.\, e^{-\frac{1}{2}x^2}$, and the corresponding ordinal values divide the curve into areas proportional to the probabilities of greater or lesser values occurring in future samples. For graphic representation in the following maps, the relative local differences have been grouped in the following manner. (See also Table VIII.) All values between $-\cdot 5$ and $+\cdot 5$ have been placed into one class, class 0, the central ordinate of the class corresponding to the abscissal value of the normal curve, $x = 0$. All values between $+\cdot 5$ and $+1\cdot 5$; $1\cdot 5$ and $2\cdot 5$; $2\cdot 5$ and $3\cdot 5$ belong to the positive classes

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* Since published. *Biometrika*, Vol. v. pp. 181—183.

TABLE VII.

Coefficients of Cephalic Correlation.

Series	Nature of Measurement	L and B				L and H				B and H				L and S			
		No.	♂	No.	♀	No.	♂	No.	♀	No.	♂	No.	♀	No.	♂	No.	♀
"Entire Insane" Pop. Scotland	Head	4436	·5026 ± ·0076	3951	·5235 ± ·0078	4436	·4027 ± ·0085	3951	·3566 ± ·0094	4436	·3761 ± ·0088	3951	·3474 ± ·0095	4401	·3284 ± ·009	3915	·2573 ± ·0101
"General Insane" Pop. Scotland	Head	4381	·4848 ± ·0079	3925	·4672 ± ·0084	4381	·3755 ± ·0089	3925	·3420 ± ·0095	4381	·3529 ± ·0090	3925	·3325 ± ·0096	—	—	—	—
Criminals*, England	Head	3000	·4016 ± ·0123	—	—	—	—	—	—	—	—	—	—	3000	·3399 ± ·018	—	—
Middle Class†, English	Head	1000	·3450 ± ·0190	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Whitechapel‡, English	Skull	131	·240 ± ·055	130	·350 ± ·051	120	·255 ± ·058	117	·425 ± ·051	116	·233 ± ·059	115	·340 ± ·056	—	—	—	—
Naqada §	Skull	139	·344 ± ·050	183	·143 ± ·049	134	·489 ± ·044	163	·283 ± ·048	129	·273 ± ·055	163	·119 ± ·052				

* Macdonell: *Biometrika*, Vol. I. pp. 181–188.

† Given by Macdonell: *Biometrika*, Vol. I. pp. 181—188.

‡ Macdonell: *Biometrika*, Vol. III. p. 233.

§ Fawcett: *Biometrika*, Vol. I. p. 455.

1, 2, and 3 respectively, the central abscissa of each class being once, twice, and three times the standard deviation of sampling respectively. It should be noted that the central abscissa of each class does not divide the class into two equal areas; it merely notes the centre of the range of the class. The last positive class is class 4, including values greater than 3·5 times the standard deviation of sampling. In a similar manner four negative classes have been instituted with the corresponding limits; class − 1 : − 5 to − 1·5 ; class − 2 : − 1·5 to − 2·5 ; class − 3 : − 2·5 to − 3·5 ; class − 4 : greater than − 3·5. The object of this grouping is to arrange the relative local differences in the order of their significance, separating those which are fair samples of the general population from those which clearly are not. The following classes of relative local differences are thus created. (Table VIII.)

TABLE VIII.

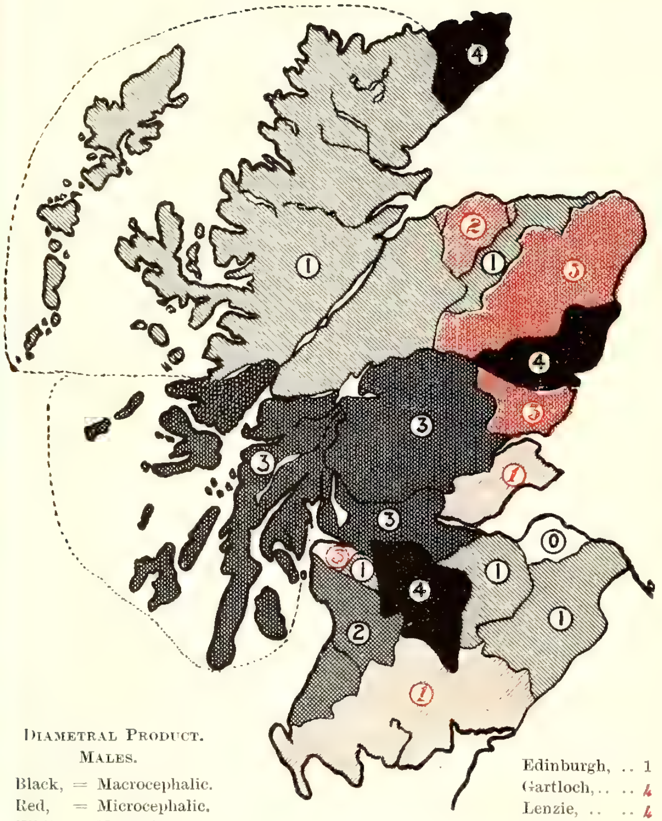
1	2	3	4	
The local mean, compared with the general mean is	Class	Range of class in terms of $(m-M)\Big/\sqrt{\frac{\Sigma^2}{N}+\frac{\sigma^2}{n}\left(1-\frac{2n}{N}\right)}$	Probabilities at extremes of range of each class. Percentage cases with greater deviations	
			Upper Limit	Lower Limit
Very much smaller	− 4	− 3·5 upwards	0	·0233
Probably significantly less	− 3	− 2·5 to − 3·5	·0233	·6210
Less, but not quite significantly less ...	− 2	− 1·5 to − 2·5	·6210	6·6807
Very slightly less	− 1	− ·5 to − 1·5	6·6807	30·8537
Quite insignificantly different	0	+ ·5 to − ·5	30·8537 to 50* and	50 to 30·8537
Very slightly greater	1	+ ·5 to 1·5	6·6807	30·8537
Greater, but not quite significantly greater	2	1·5 to 2·5	·6210	6·6807
Probably significantly greater	3	2·5 to 3·5	·0233	·6210
Very much greater	4	3·5 upwards	0	·0233

Relative local differences falling beyond + 2 and − 2 may be regarded as probably significant since the number of asylums is small (22), and since the probability that a greater deviation than that occurring at the furthest extreme on the range of this class is about 1 in 81, while the value for the central abscissa of this class is about 1 in 22. The figures in the fourth column obviously express the probable number of deviations from the general mean (per cent.) in future samples for the upper and lower limits of each class.

The distribution constants of each character for the whole population being used as a basis, the constants for each character in the various districts throughout Scotland will now be discussed. The relative differences between the local means and the rest of the population for each character are first considered.

* 50 = P. for centre of this class.

I.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3
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5
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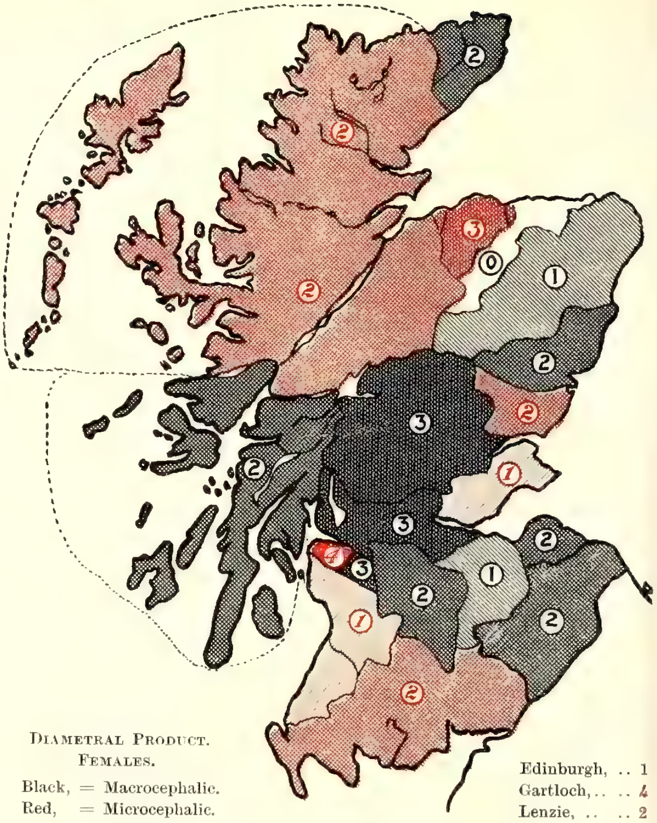
1
4
1
2
1

DIAMETRAL PRODUCT.
MALES.
Black, = Macrocephalic.
Red, = Microcephalic.
White, = Neutral.

Edinburgh, .. 1
Gartloch, ... *4*
Lenzie, ... *4*
Govan, ... *3*

II.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1
2
2
2
3
2
1
3
4
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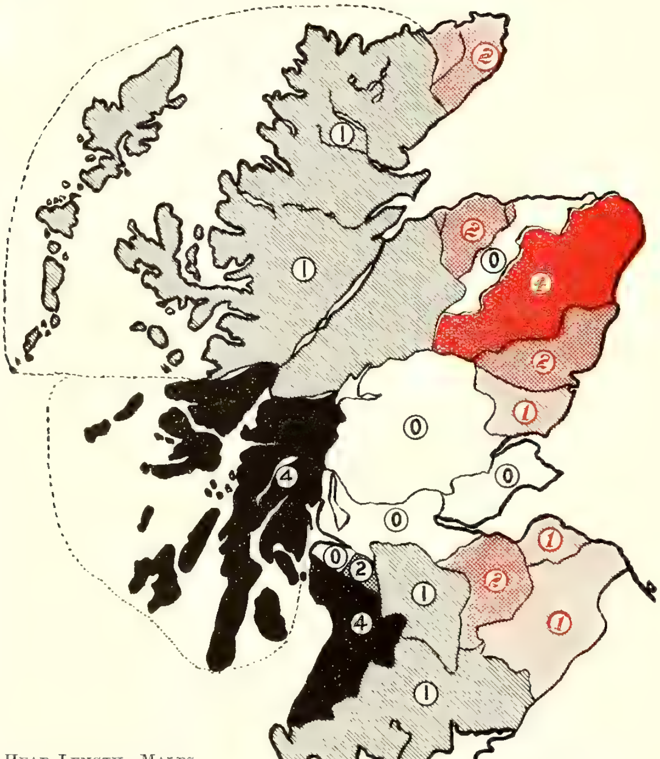
2
1
2
1
2
2

DIAMETRAL PRODUCT.
FEMALES.
Black, = Macrocephalic.
Red, = Microcephalic.
White, = Neutral.

Edinburgh, .. 1
Gartloch, ... *4*
Lenzie, ... 2
Govan, ... *1*

III.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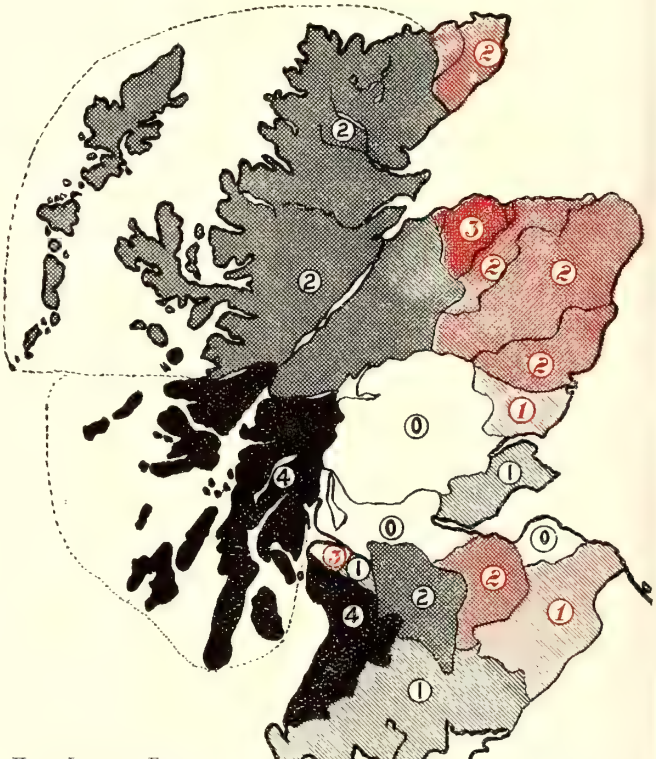
1
4
2
1
0
4
0
0
1
0
2
2
1
1
4
1

HEAD LENGTH—MALES.
Black, = Macrocranial.
Red, = Brachycranial.
White, = Neutral.

Edinburgh, .. *3*
Gartloch, ... *0*
Lenzie, ... *4*
Govan, ... 1

IV.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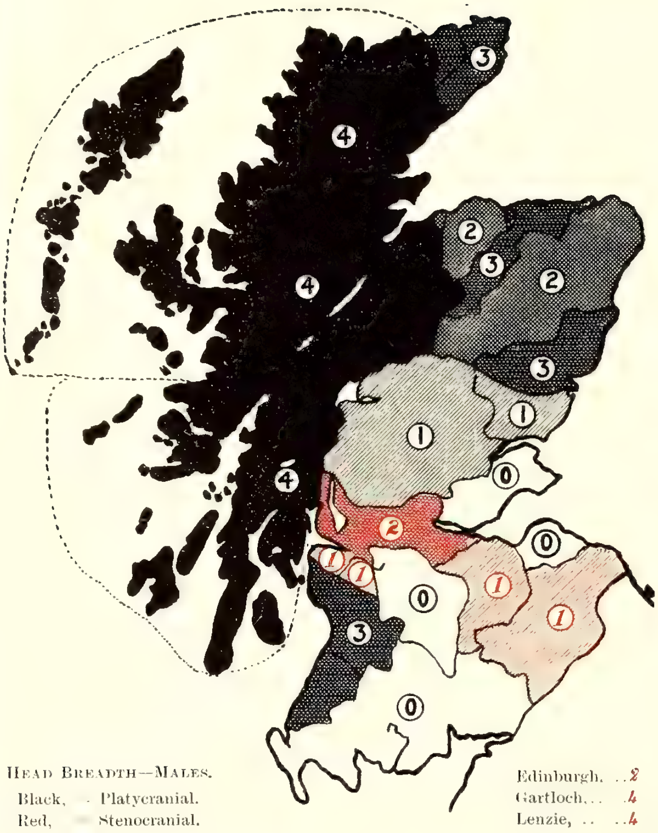
2
2
2
2
1
0
4
1
0
0
3
1
2
2
1
4
1

HEAD LENGTH—FEMALES.
Black, = Macrocranial.
Red, = Brachycranial.
White, = Neutral.

Edinburgh, .. *3*
Gartloch, ... *2*
Lenzie, ... *0*
Govan, ... *2*

V.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2
3
4
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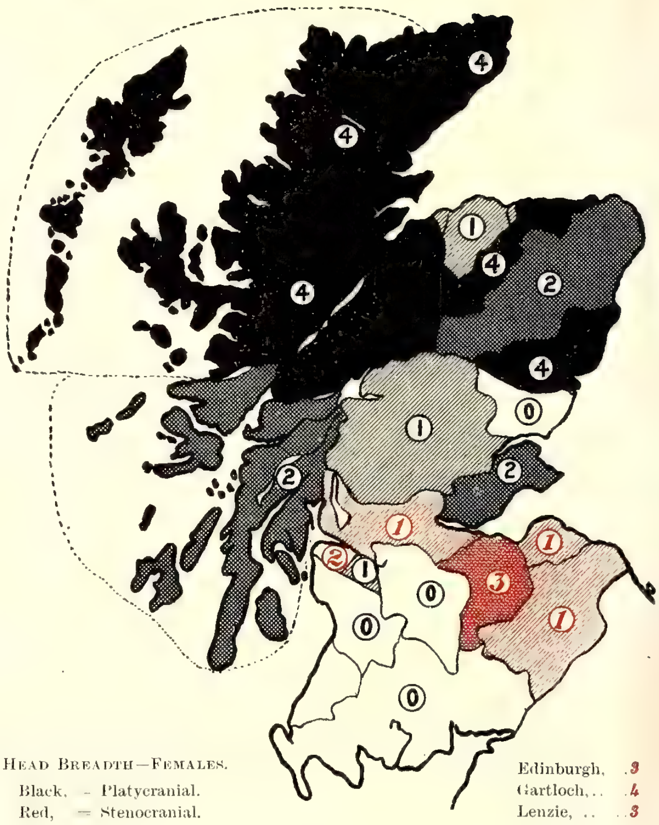
3
1
1
4
0
2
0
1
1
0
1
1
3
0

HEAD BREADTH—MALES.

Black, - Platycranial.
Red, — Stenocranial.
White, — Neutral.

Edinburgh, .. 2
Gartloch, .. .4
Lenzie, ...4
Govan, .. . 2

VI.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4
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4
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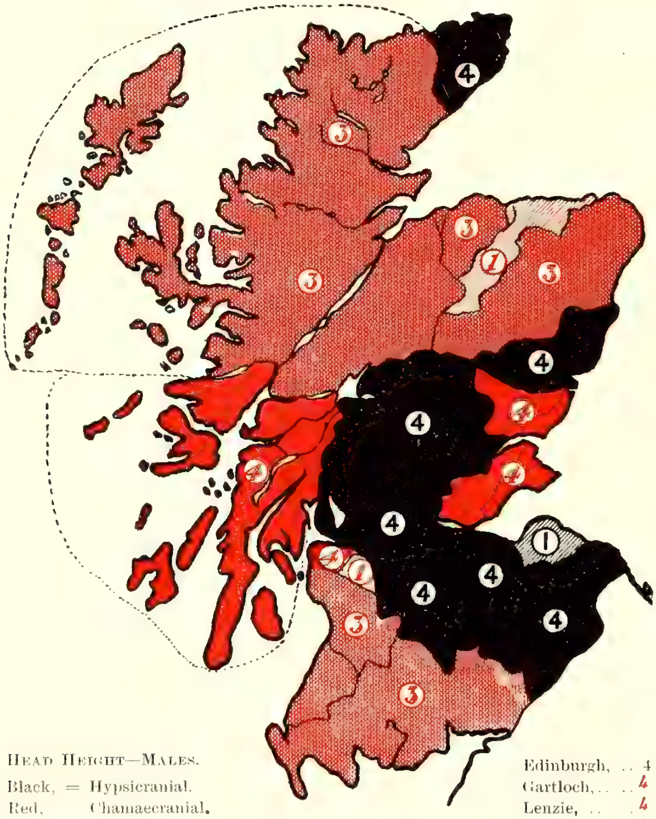
0
2
2
1
1
2
1
0
3
1
0
0

HEAD BREADTH—FEMALES.

Black, - Platycranial.
Red, = Stenocranial.
White, = Neutral.

Edinburgh, .3
Gartloch, .. .4
Lenzie, ...3
Govan, ...2

VII.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3
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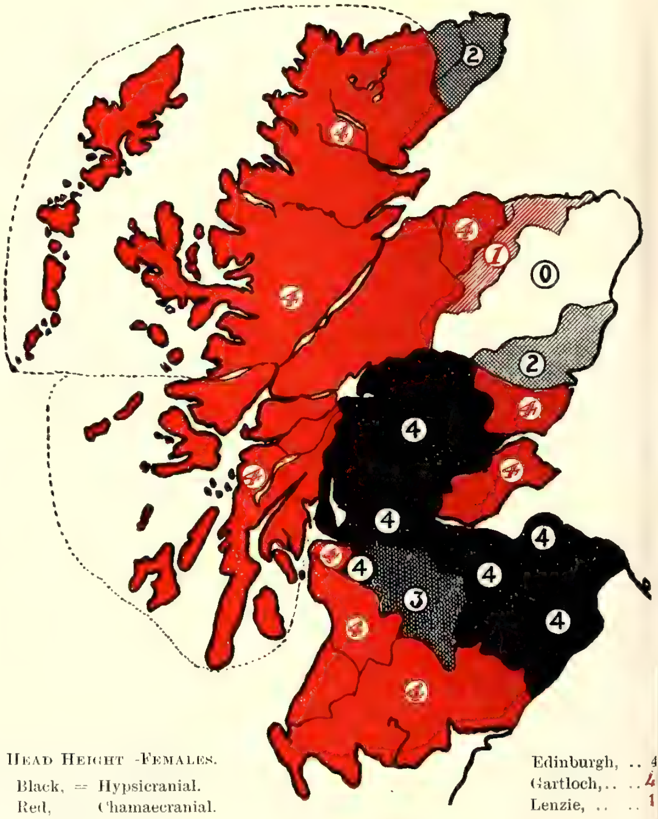
1
3
4
4
4
4
4
1
4
1
4
4
3
4
3

HEAD HEIGHT—MALES.

Black, = Hypsicranial.
Red, Chamaecranial.
White, = Neutral.

Edinburgh, .. 4
Gartloch, ...4
Lenzie, .. .4
Govan, ...3

VIII.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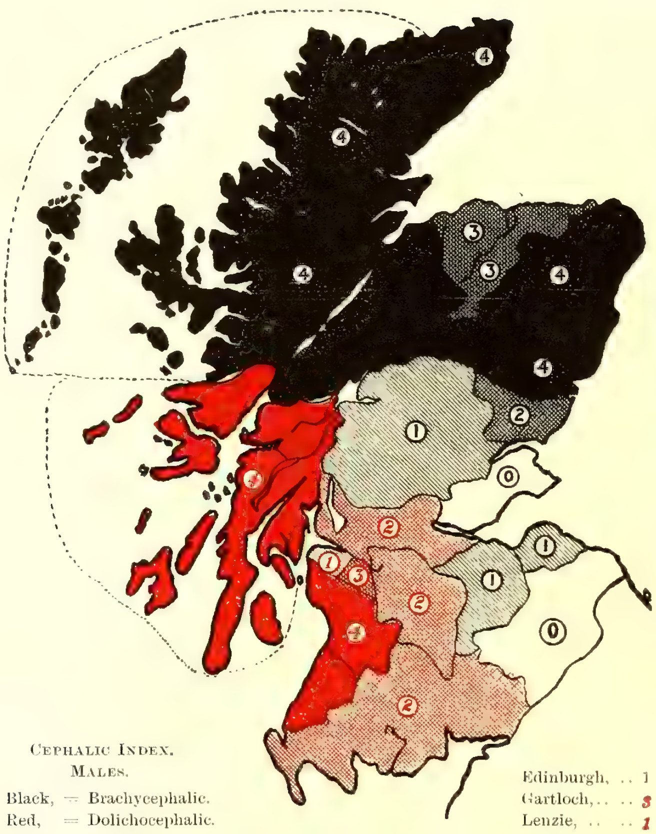
4
1
0
4
2
4
4
4
4
4
4
4
4
3
4
4
4

HEAD HEIGHT -FEMALES.

Black, = Hypsicranial.
Red, Chamaecranial.
White, = Neutral.

Edinburgh, .. 4
Gartloch, ...4
Lenzie, ... 1
Govan, ... 1

IX.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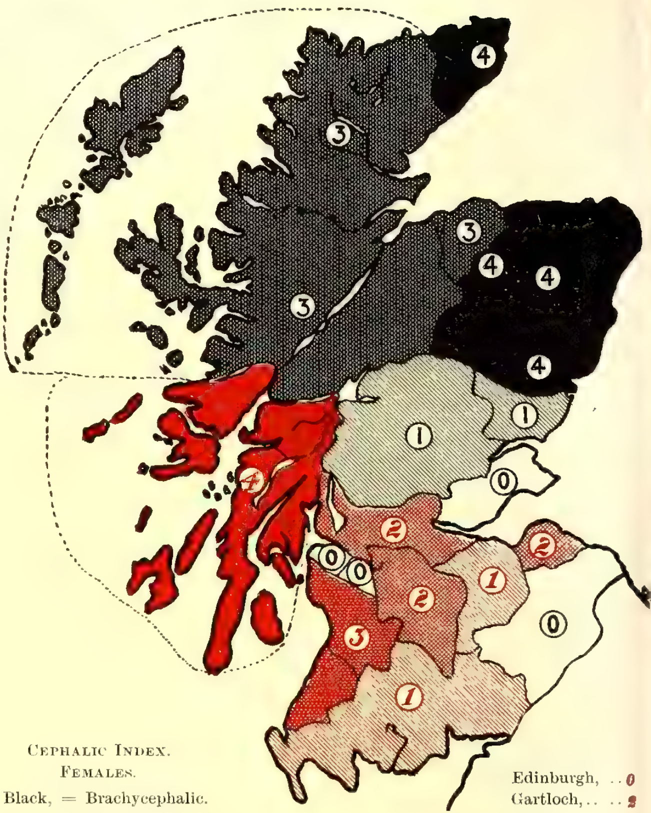
4
3
3
4
4
4
2
1
0
2
1
1
3
2
1
0
2

CEPHALIC INDEX.
MALES.
Black, = Brachycephalic.
Red, = Dolichocephalic.
White, = Neutral.

Edinburgh, .. 1
Gartloch, ... *3*
Lenzie, ... *1*
Govan, ... *3*

X.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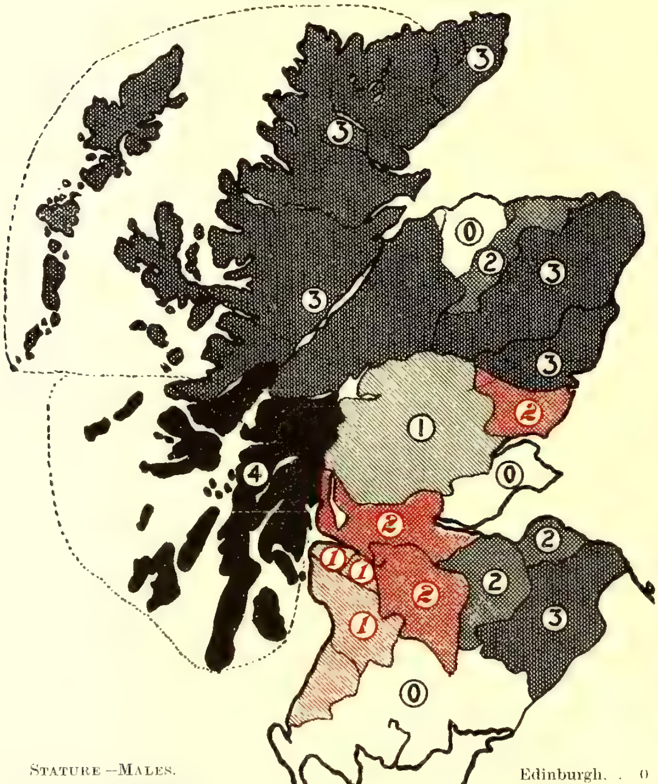
3
3
4
4
3
4
1
1
0
4
2
0
0
2
1
2
3
0
1

CEPHALIC INDEX.
FEMALES.
Black, = Brachycephalic.
Red, = Dolichocephalic.
White, = Neutral.

Edinburgh, .. *0*
Gartloch, ... *2*
Lenzie, ... *3*
Govan, ... *0*

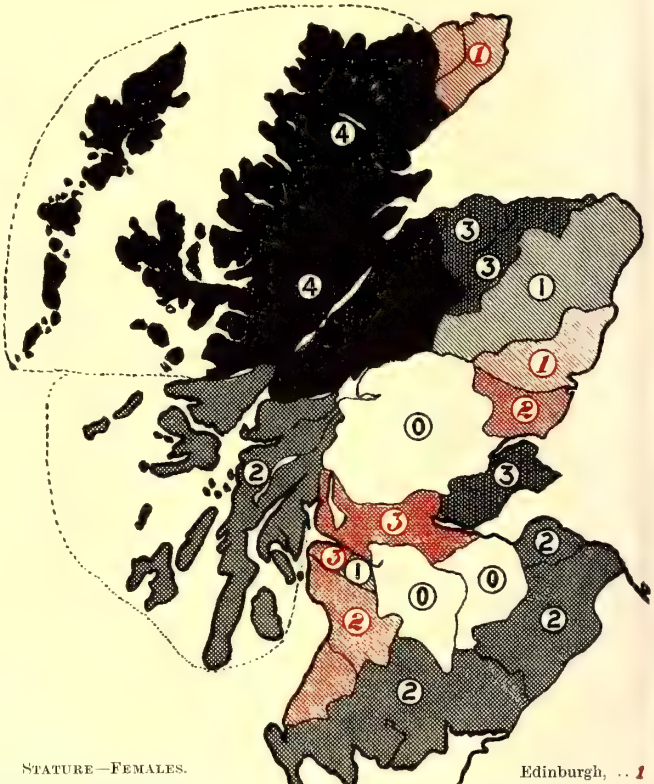
XI.


3
3
0
2
3
3
3
2
1
4
0
2
2
1
1
2
2
2
1
3
0

STATURE —MALES.
Black, = Megalomegithic.
Red, Micromegithic.
White, = Neutral.

Edinburgh, . 0
Gartloch, ... *3*
Lenzie, ... *4*
Govan, ... 2

XII.


1
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3
3
4
1
1
2
0
2
3
3
2
3
1
0
0
2
2
2

STATURE—FEMALES.
Black, = Megalomegithic.
Red, = Micromegithic.
White, = Neutral.

Edinburgh, .. *1*
Gartloch, . .. *2*
Lenzie, ... *4*
Govan, ... *0*

I. *Individual Characters.*—Head Length. (See Maps III. and IV.) An inspection of the accompanying maps reveals the fact that, exclusive of Glasgow, the west (and particularly the south-west) of Scotland has a long-headed or macrocranial population of inmates, while the north-east population is distinctly brachycranial. Edinburgh and Midlothian generally are slightly brachycranial. Among the Glasgow asylums, nothing striking in head length is noted, except among the males at Lenzie, who are as distinctly brachycranial* as the north-east population. The macrocranial inmates are those of Argyll, Ayr, and Renfrew, while the Inverness group (including Ross and Sutherland), and the Dumfries group (including Kirkcudbright and Wigton and Lanark) show this characteristic only in a slight degree. The Inverness females are more markedly macrocranial than the males. In a general way, a line drawn from the most northern part of the boundary between Sutherland and Caithness to the boundary between Dumfries and Cumberland on the Solway firth divides Scotland into a macrocranial and a brachycranial population.

Head Breadth. (See Maps V. and VI.) Quite a different grouping is shown among head breadths. The north of Scotland is distinctly broad-headed or platycranial, while the populous centres round about Glasgow and Edinburgh, and these towns themselves, show stenocranial characteristics or narrow-headedness. The female inmates of Edinburgh and Midlothian are more stenocranial than the males, while those of Argyll are less platycranial than the male inmates of the same asylum. The platycraniality of the Ayr males is probably significant. The inmates, of both sexes, at the Glasgow asylums, Gartloch, Lenzie and Govan, agree in showing distinct narrow-headedness or stenocraniality.

Cephalic Index. (See Maps IX. and X.) The ratio $i = 100\,B/L$ is conveniently taken after the characters B and L. The results are even more striking than those of the characters just mentioned. The means and standard deviations were calculated from the formulae deduced by Pearson†, and the tables and maps show the differences, with respect to the standard deviations of sampling of these differences of means in the usual way. The north of Scotland is distinctly brachycephalic, while the south, particularly the south-west, is dolichocephalic. This condition of affairs is common to both male and female inmates, the only exceptions of significance being that of (1) Govan, the females there being mesocephalic or differing little from the general population, while the males agree with the surrounding population in being distinctly dolichocephalic, and (2) of Haddington, the females there being rather dolichocephalic, while the males show slight brachycephaly. In such distinctly Highland counties as Argyll, Perth and Inverness, Argyll differs from the other two in being strikingly dolichocephalic, and from the whole population in actual size of head, as will be seen later. Perth and Fife are buffer counties, and the remaining portion of Scotland to the west is divided off by Inverness in the north and Argyll in the south, thus bisecting the country north and south into a brachycephalic northern population and a dolichocephalic southern one.

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* All the terms of this section are used in the sense indicated by C. D. Fawcett, Alice Lee and K. Pearson, in the memoir on Naqada crania: *Biometrika*, Vol. I. p. 462.

† *Proc. R. S.* Vol. 60, p. 492.

LB product. If the product $L \times B = p_a$ be now considered, an idea may be gathered as to the magnitudes of the sectional areas in the length-breadth plane to which the products are proportional. The ratio $i = 100\,B/L$ deals only with the shape of the head in the same plane. An evaluation of the product enables an inspection to be made of the various mean values of p_a with the same or different mean values of i. It is to be observed that large sectioned and small sectioned groups may have the same cephalic index. Thus groups may be similar in shape but significantly different in size of section, due to greater or lesser length or breadth. A comparison of the values of length, breadth and cephalic index would of course bring out the facts, but it would be interesting to know the values of the means and standard deviations of the product in order to perceive by direct inspection significant differences of mean section. Before, however, the means and standard deviations of these products can be evaluated $\bar{p}_a$ and Σ_p have to be deduced in a manner similar to that employed for the ratio $100\,B/L$. Adopting the notation used by Pearson in the paper already referred to, if x_1, x_2 be the absolute magnitudes of any two correlated characters; m_1, m_2 their means; σ_1, σ_2 their standard deviations; r_{12} their coefficient of correlation; $\bar{p}_a$ the mean value of the distribution of x_1, x_2; Σ_{p_a} the standard deviation of the same distribution;

$$v_1 = \frac{\sigma_1}{m_1} \text{ and } v_2 = \frac{\sigma_2}{m_2}; \quad \epsilon_1 = x_1 - m_1 \text{ and } \epsilon_2 = x_2 - m_2;$$

and finally n = the total number of pairs, then

$$\bar{p}_a = \frac{1}{n} S(x_1 x_2) = \frac{1}{n} S\left[m_1 m_2 \left(1 + \frac{\epsilon_1}{m_1}\right)\left(1 + \frac{\epsilon_2}{m_2}\right)\right]$$

$$= \frac{m_1 m_2}{n} S\left(1 + \frac{\epsilon_1}{m_1} + \frac{\epsilon_2}{m_2} + \frac{\epsilon_1\epsilon_2}{m_1 m_2}\right)$$

and summing
$$= m_1 m_2 \left(1 + \frac{S(\epsilon_1\epsilon_2)}{n m_1 m_2}\right)$$

or
$$\bar{p}_a = m_1 m_2 + r_{12}\sigma_1\sigma_2 \quad \ldots\ldots (1).$$

The standard deviation is then found as follows:—

$$n\Sigma^2_{p_a} = S(x_1 x_2 - \bar{p}_a)^2$$

$$= m_1^2 m_2^2 S\left(\frac{\epsilon_1}{m_1} + \frac{\epsilon_2}{m_2} + \frac{\epsilon_1\epsilon_2}{m_1 m_2} - r_{12}v_1v_2\right)^2$$

$$= m_1^2 m_2^2 \left[S\left(\frac{\epsilon_1}{m_1}\right)^2 + S\left(\frac{\epsilon_2}{m_2}\right)^2 + 2\frac{S(\epsilon_1\epsilon_2)}{m_1 m_2} + \frac{S(\epsilon_1^2\epsilon_2^2)}{m_1^2 m_2^2} - \frac{S(\epsilon_1\epsilon_2)}{m_1 m_2} r_{12}v_1v_2 + r_{12}^2 v_1^2 v_2^2 + \frac{2S(\epsilon_1^2\epsilon_2)}{m_1^2 m_2} + \frac{2S(\epsilon_1\epsilon_2^2)}{m_1 m_2^2}\right].$$

Since $S(\epsilon_1^2\epsilon_2) = S(\epsilon_1\epsilon_2^2) = 0$ on the assumption of normal correlation, and since $S(\epsilon_1^2\epsilon_2^2) = n\sigma_1^2\sigma_2^2(1+2r_{12}^2)$ on the same hypothesis, we have:

$$n\Sigma^2_{p_a} = m_1^2m_2^2\left[nv_1^2 + nv_2^2 + 2nr_{12}v_1v_2 + nv_1^2v_2^2(1+r_{12}^2)\right].$$

The term $nv_1^2v_2^2(1+r_{12}^2)$ does not appreciably affect the result and may be neglected. Thus

$$\Sigma_{p_a} = m_1m_2\left[v_1^2 + v_2^2 + 2r_{12}v_1v_2\right]^{\frac{1}{2}} \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2).$$

An inspection of the relative local differences of $\bar{p}_a$, in Table IX., reveals the fact that the entire west of Scotland is large sectioned and that the east country south of the Forth is small sectioned, compared with the general population. These deductions can, of course, be made from the lengths and breadths themselves, but the facts do not come out so clearly. It is seen that Argyll and Ayr have large cross sections because of their long-headedness, while in the Inverness group's large section is due to the group's broad-headedness. It is also to be noted that both Edinburgh and Glasgow have small product means.

Diametrical Product. (See Maps I. and II.) This product $L \times B \times H = p_\beta$ is a useful character, supplying as it does, an estimate of the mean relative size of head in each of the asylum groups. The means and standard deviations were calculated from the following formulae, derived by the same process of reasoning and approximation as that employed to deduce the mean and standard deviation of the LB product.

$$\bar{p}_\beta = \frac{1}{n}S(x_1x_2x_3) = m_1m_2m_3\left[1 + r_{12}v_1v_2 + r_{13}v_1v_3 + r_{23}v_2v_3\right] \quad\ldots\ldots\ldots\ldots(3)$$

and

$$\Sigma_{p_\beta} = m_1m_2m_3\left[v_1^2 + v_2^2 + v_3^2 + 2r_{12}v_1v_2 + 2r_{13}v_1v_3 + 2r_{23}v_2v_3\right]^{\frac{1}{2}} \quad\ldots\ldots\ldots\ldots(4).$$

In the region of Scotland south of the Grampians and north of the Border and Galloway (that is, practically the Scottish Midlands), with the exceptions of the large towns of Glasgow, Dundee, Aberdeen and Greenock, the asylum inmates are large-headed or macrocephalic. In the above mentioned towns they are small-headed or microcephalic. Edinburgh and the rest of the country approximates to the mean diametral product. The large-headed or macrocephalic group consists of Argyll and Lanark (which are dolichocephalic), and Montrose, Perth and Stirling (which are brachycephalic). *It is plainly evident that, excluding Edinburgh, the inmates of asylums in the great cities are smaller headed than those of the rest of the country, that is, they are a microcephalic population.* The only significantly small-headed or microcephalic rural group is that of Elgin, where there are only 71 male and 89 female inmates. Aberdeen females are medium sized or mesocephalic, while Inverness females are smaller sized than the males. The distribution of relative size of head is shown as follows:—

TABLE VIII. (*bis*).

Diametral Product.

Significantly Large = Macrocephalic		Medium = Mesocephalic		Significantly Small = Microcephalic	
Males	Females	Males	Females	Males	Females
Montrose	Montrose	Fife	Fife	Gartloch	Gartloch
Perth	Perth	Banff	Banff	Lenzie	Lenzie
Stirling	Stirling	Midlothian	Midlothian	Govan	Govan
Lanark	Lanark	Edinburgh	Edinburgh	Dundee	Dundee
Argyll	Argyll	Inverness	Ayr	Greenock	Greenock
Ayr	Roxburgh	Roxburgh	Aberdeen	Elgin	Elgin
	Haddington	Haddington		Aberdeen	Inverness
	Paisley	Dumfries			Dumfries
		Paisley			

Head Height. (See Maps VII. and VIII.) The means of this character show greater variability than those of any other character do. This is at once seen from the interlocal constants, discussed further on. The inmates are divided sharply into two groups, (1) a high-headed or hypsicranial group, and (2) a low-headed or chamaecranial one. The Scottish Midlands are hypsicranial. Inverness, Aberdeen, Elgin, Argyll, Ayr, Galloway—all contiguous—are chamaecranial, as also are Fife and Dundee. Edinburgh city differs from Glasgow, Dundee and Aberdeen in being hypsicranial, agreeing with the surrounding country in this distinguishing feature. Males and females agree generally, the exceptions being Paisley, and to a lesser extent Haddington, Lenzie and Aberdeen.

Stature. (See Maps XI. and XII.) Glasgow and its environs, Paisley, Greenock, Lanark, Stirling and Ayr differ materially from the rest of Scotland with respect to stature. The inmates of this group are short-statured or micromegithic. The female inmates of Govan and Lanark, however, differ very little from the general mean. The males of the entire north (excepting Elgin, which is average statured or mesomegithic) and the border counties are tall-statured or megalomegithic. Galloway males approximate the mean. Taking the cases from the tallest downwards, the order of the asylums are as follows:—Argyll, Inverness, the Border counties, Aberdeen, Banff and Haddington. The shortest inmates are found at Lenzie, and then follow Gartloch, Stirling, Lanark and Dundee. Generally speaking the asylum population is shorter in the neighbourhood of the great cities and in these cities themselves than in the rest of Scotland.

The foregoing statements are based on results which are embodied in the following table.

TABLE IX.

$$\left(\textit{Values of } (m-M)\sqrt{\frac{\Sigma^2}{N}+\frac{\sigma^2}{n}\left(1-\frac{2n}{N}\right)}\right).$$

Relative Local Differences of Means.

	L	B	H	p_a	p_β	i	S
Males							
Aberdeen ...	−4·68	1·92	−3·40	−1·58	−2·74	6·40	2·77
Dumfries ...	1·41	− ·35	−3·44	·59	−1·05	−1·66	·37
Dundee ...	− ·56	1·27	−7·52	·40	−2·81	1·84	−1·67
Edinburgh ...	−2·55	−1·54	5·69	−2·40	1·04	·85	− ·13
Montrose ...	−1·59	3·04	6·90	·82	3·96	4·55	2·79
Argyll ...	8·08	3·90	−4·29	6·82	3·21	−3·79	4·92
Ayr ...	5·98	2·51	−3·05	4·77	2·08	−3·82	−1·14
Banff ...	·22	2·80	−1·22	1·84	·76	2·71	1·77
Elgin ...	−1·60	1·51	−3·07	·08	−1·58	2·97	− ·35
Fife ...	·46	·39	−3·88	·46	−1·30	− ·05	− ·12
Glasgow (Gartloch)	− ·39	−3·66	−5·95	−2·43	−4·46	−3·37	−3·42
„ (Lenzie)	−5·42	−5·57	−4·85	−6·46	−6·95	− ·60	−7·76
Govan ...	·76	−2·26	−3·33	−1·96	−2·21	−3·04	2·09
Haddington ...	− ·72	− ·05	·56	− ·43	·05	·57	2·03
Inverness ...	1·23	4·57	−3·33	3·56	·64	3·72	3·43
Lanark ...	·77	− ·21	6·11	1·10	3·63	−2·44	−1·69
Midlothian ...	−2·45	−1·31	5·98	−2·12	1·25	·64	1·58
Perth ...	− ·37	+1·09	5·90	·45	3·37	1·43	1·49
Roxburgh ...	− ·58	− ·83	3·95	− ·84	1·09	− ·31	2·89
Stirling ...	− ·20	−2·14	7·71	−1·39	2·70	−1·95	−2·05
Greenock ...	·14	− ·79	−6·80	− ·40	−3·15	− ·96	−1·28
Paisley ..	1·72	−1·11	−1·03	·43	·69	−2·78	−1·13
Females							
Aberdeen ...	−1·93	2·16	·49	·11	·56	4·04	·56
Dumfries ...	1·16	·37	−5·79	1·04	−1·79	− ·73	1·79
Dundee ...	−1·28	− ·30	−3·54	− ·89	−2·26	·94	−1·68
Edinburgh ...	−3·04	−2·85	6·68	−3·44	·92	− ·23	−1·11
Montrose ...	−2·06	3·78	1·98	1·24	1·92	5·54	−1·01
Argyll ...	6·12	1·70	−3·61	4·58	1·70	−4·38	2·41
Ayr ...	4·02	·45	−6·56	2·48	− ·85	−3·20	−1·75
Banff ...	−1·73	4·36	−1·13	1·37	·28	5·73	2·94
Elgin ...	−2·62	·96	−4·78	− ·94	−3·06	3·42	3·37
Fife ...	+1·38	1·51	−4·15	1·69	− ·71	·23	3·50
Glasgow (Gartloch)	−1·83	−4·40	−6·44	−3·64	−5·75	−2·48	−2·45
„ (Lenzie)	·00	−3·14	− ·59	−1·86	−1·64	−3·07	−6·10
Govan ...	−1·76	−2·19	1·47	−2·32	−1·11	− ·43	·18
Haddington ...	·35	−1·33	5·67	− ·62	2·30	−1·68	1·71
Inverness ...	1·84	5·18	−8·83	4·09	−2·01	3·18	5·06
Lanark ...	1·62	− ·50	2·71	·63	1·75	−2·05	·41
Midlothian ...	−1·51	−2·58	5·30	−2·36	1·11	− ·95	·02
Perth ...	·17	·76	5·57	·56	2·73	·61	·02
Roxburgh ...	− ·99	− ·72	5·85	− ·99	2·48	·09	2·33
Stirling ...	·13	−1·43	7·46	− ·78	3·33	−1·56	−3·38
Greenock ...	−2·51	−1·64	−4·83	−2·38	−4·02	·43	−3·43
Paisley ...	·98	1·03	3·69	1·18	2·57	·06	1·17

II. *Interlocal and Intralocal Characteristics.* If the distribution of the differences of means of any one character throughout the whole of the asylums be considered, and the variability of the distribution for each character be determined, an accurate estimate can be formed as to the relative homogeneity of the general population, with respect to each separate character. If the whole population be homogeneous the relative differences between the general and local means should be expressed by a random distribution. It should be again noted that the relative local differences (*RLD*) are the differences between the general mean M and the local means m reduced to a common scale by dividing each difference by its standard deviation, i.e. the ratios

$$(m - M) \Big/ \sqrt{\frac{\Sigma^2}{N} + \frac{\sigma^2}{n}\left(1 - \frac{2n}{N}\right)}$$

for each character at each asylum are considered interlocally. If the population be a homogeneous one with respect to the character considered, the standard deviation of the distribution of these ratios interlocally, or s, will seldom differ from unity by a quantity greater than three times the probable error of s, or $s = 1 \pm \frac{\cdot 67449}{\sqrt{2q}}$ where q is the number of districts considered. Thus s is an interlocal constant determining the degree of homogeneity of the characters considered or the degree of character homogeneity. An attempt has also been made to discover the degree of district or local homogeneity, using the values of the relative local differences intralocally, but the writer has failed to find a solution of this interesting problem. As Professor Pearson has pointed out no attempt can be successful which neglects intralocal correlations, and since head characters are all more or less highly correlated, the reasoning employed with respect to the relative local differences interlocally is not applicable intralocally. It is to be hoped that Professor Pearson will find time to furnish anthropometricians with a solution.

The numerical portion of the following tables (Tables X. and XI.) gives the values of the interlocal constants, h being the mean of the distribution of (*RLD*) m interlocally and $(s-1)$ the deviation from homogeneity of the general population for the various characters shown in the table. In the body of the table the distinguishing feature of each character is shown for each asylum, the terms employed to describe significant excess or defect of local means from the general mean being those already referred to in C. D. Fawcett's memoir, except where new terms are used, as defined in the text and in the "synopsis of terms." Where the blanks occur in the table, approximations to the general mean are indicated. This table should be examined in conjunction with the character maps and the diagrams of relative local differences. Confining attention in the first instance to one character at a time, it has already been noted that if the population had been an entirely homogeneous one, the value of $s - 1 = 0$ and the groups at the various asylums would have simply been fair random samples of the whole. The magnitudes of many of the relative local differences show this is not the case.—The values of $(s-1)$ for the character H (♂ and ♀), viz. 3·89 and 3·95, compared with their probable errors, are very large, thus indicating a very significant deviation from homogeneity interlocally. The values of $(s-1)$ for all

TABLE X.

Specification of Asylum Population.—Males.

	L	B	H	i	p_β	S	General Description
Aberdeen ...	Brachycranial	Platycranial	Chamaecranial	Brachycephalic	Microcephalic	Megalomegithic	Mictomeric
Dumfries ...	—	—	Chamaecranial	Dolichocephalic	—	—	Isomeric
Dundee ...	—	—	Chamaecranial	Brachycephalic	Microcephalic	Micromegithic	Mictomeric
Edinburgh ...	Brachycranial	Stenocranial	Hypsicranial	—	—	—	Mictomeric
Montrose ...	Brachycranial	Platycranial	Hypsicranial	Brachycephalic	Macrocephalic	Megalomegithic	Megalomeric
Argyll	Macrocranial	Platycranial	Chamaecranial	Dolichocephalic	Macrocephalic	Megalomegithic	Megalomeric
Ayr	Macrocranial	Platycranial	Chamaecranial	Dolichocephalic	Macrocephalic	—	Megalomeric
Banff	—	Platycranial	—	Brachycephalic	—	Megalomegithic	Iso-megalomeric
Elgin	Brachycranial	Platycranial	Chamaecranial	Brachycephalic	Microcephalic	—	Mictomeric
Fife	—	—	Chamaecranial	—	—	—	Isomeric
Glasgow (Gart.)	—	Stenocranial	Chamaecranial	Dolichocephalic	Microcephalic	Micromegithic	Micromeric
Do. (Lenzie)	Brachycranial	Stenocranial	Chamaecranial	—	Microcephalic	Micromegithic	Micromeric
Govan	—	Stenocranial	Chamaecranial	Dolichocephalic	Microcephalic	Megalomegithic	Micromeric
Haddington ...	—	—	—	—	—	Megalomegithic	Isomeric
Inverness ...	—	Platycranial	Chamaecranial	Brachycephalic	—	Megalomegithic	Mictomeric
Lanark	—	—	Hypsicranial	Dolichocephalic	Macrocephalic	Micromegithic	Mictomeric
Midlothian ...	Brachycranial	—	Hypsicranial	—	—	Megalomegithic	Mictomeric
Perth	—	—	Hypsicranial	—	Macrocephalic	—	Isomeric
Roxburgh ...	—	—	Hypsicranial	—	—	Megalomegithic	Mictomeric
Stirling ...	—	Stenocranial	Hypsicranial	Dolichocephalic	Macrocephalic	Micromegithic	Mictomeric
Greenock ...	—	—	Chamaecranial	Dolichocephalic	Microcephalic	—	Isomeric
Paisley	Macrocranial	—	—	Dolichocephalic	—	—	Isomeric
h $s-1$	−·015 1·855	·167 1·424	−·562 3·890	·041 1·778	−·077 1·790	·054 1·422	—

TABLE XI.

Specification of Asylum Population.—Females.

	L	*B*	*H*	*i*	p_β	*S*	General Description
Aberdeen ...	Brachycranial	Platycranial	—	Brachycephalic	—	—	Mictomeric
Dumfries ...	—	—	Chamaecranial	—	Microcephalic	Megalomegithic	Mictomeric
Dundee	—	—	Chamaecranial	—	Microcephalic	Micromegithic	Micro-isomeric
Edinburgh ...	Brachycranial	Stenocranial	Hypsicranial	—	—	—	Mictomeric
Montrose ...	Brachycranial	Platycranial	Hypsicranial	Brachycephalic	Macrocephalic	—	Mictomeric
Argyll ...	Macrocranial	Platycranial	Chamaecranial	Dolichocephalic	Macrocephalic	Megalomegithic	Megalomeric
Ayr	Macrocranial	—	Chamaecranial	Dolichocephalic	—	Micromegithic	Megalomeric
Banff	Brachycranial	Platycranial	—	Brachycephalic	—	Megalomegithic	Iso-megalomeric
Elgin	Brachycranial	—	Chamaecranial	Brachycephalic	Microcephalic	Megalomegithic	Mictomeric
Fife	—	Platycranial	Chamaecranial	—	—	Megalomegithic	Micto-isomeric
Glasgow (Gartloch)	Brachycranial	Stenocranial	Chamaecranial	Dolichocephalic	Microcephalic	Micromegithic	Micromeric
Do. (Lenzie)	—	Stenocranial	—	Dolichocephalic	—	Micromegithic	Iso-micromeric
Govan	Brachycranial	Stenocranial	—	—	—	—	Micro-isomeric
Haddington ...	—	—	Hypsicranial	Dolichocephalic	Macrocephalic	Megalomegithic	Megalo-isomeric
Inverness ...	Macrocranial	Platycranial	Chamaecranial	Brachycephalic	Microcephalic	Megalomegithic	Micto-megameric
Lanark	—	—	Hypsicranial	Dolichocephalic	—	—	Megalo-isomeric
Midlothian ...	Brachycranial	Stenocranial	Hypsicranial	—	—	—	Micto-isomeric
Perth	—	—	Hypsicranial	—	Macrocephalic	—	Megalo-isomeric
Roxburgh ...	—	—	Hypsicranial	—	Macrocephalic	Megalomegithic	Megalo-isomeric
Stirling	—	—	Hypsicranial	Dolichocephalic	Macrocephalic	Micromegithic	Micto-isomeric
Greenock ...	Brachycranial	Stenocranial	Chamaecranial	—	Microcephalic	Micromegithic	Micro-isomeric
Paisley	—	—	Hypsicranial	—	Macrocephalic	—	Megalo-isomeric
h *s* − 1	− ·158 1·123	·053 1·421	− ·154 3·953	·159 1·690	− ·073 1·384	·207 1·625	—

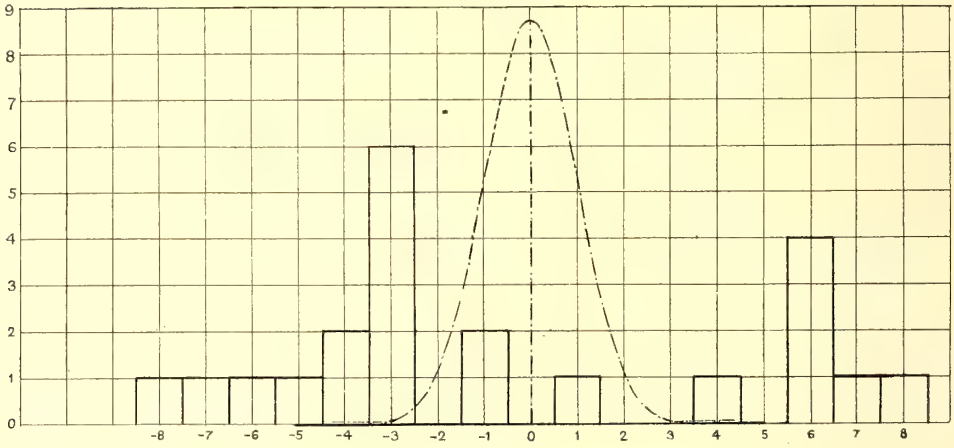
the other characters, compared with $E_{(s-1)}$ also show that the differences, although not so large as in H, are all quite significant, and indicate that, passing from asylum to asylum, the means vary very considerably. In other words, while some local groups are fair samples of the "general insane" population for one or more characters, the majority of them are not fair samples. Individual asylum groups as a whole therefore cannot be said to form part of a "general insane" population *of a homogeneous character*. On the contrary, considered interlocally, asylum groups as a whole show great heterogeneity—greatest in the character H. An inspection of the table shows what has already been demonstrated regarding this character, its great variability from asylum to asylum. If the differences, grouped as already indicated, be arranged in the order of their frequency it is quite clear that the homogeneity curve $y = \frac{22}{\sqrt{2\pi}} e^{-\frac{1}{2}x^2}$ does not in the least fit the distribution, as Diagrams X (A and B) show. The frequency at the mean approximates to a minimum instead of a maximum value. The diagrams and maps show, what the analysis clearly indicates, that there are really two very distinct groups, a high-headed or hypsicranial and a low-headed or chamaecranial one.

Examining now the relative local differences intralocally, we can form an idea of the anthropometric character of each individual asylum. Take striking cases: Argyll males and females show macro-, platy-, and chamae-craniality; they are therefore large sectioned. p_β is large; they are thus large-headed or macrocephalic and they are tall-statured or megalomegithic. Viewing dolichocephaly as a defect of i, this is the only significant defect among the Argyll inmates. With the exception of p_β (♀), all these characteristics are significant excesses from their respective means. Thus the Argyll group of inmates is the most significantly different. The group is a megalomeric one, most of its characters being megalometropic. By megalomeric is meant that the group possesses, on an average, greater magnitudes of the various characters measured than the general population of inmates. By megalometropic is meant that, in reference to the magnitude of any character, the value found is significantly greater than the value of the corresponding constant with which it is compared; by micrometropic, that the value is significantly less; and isometropic means that it is insignificantly different, with reference to the constant. Lenzie inmates show almost as great deviations as Argyll inmates do. The body of the table shows Lenzie to possess brachy-steno-chamaecranial inmates, small sectioned and short-statured. The group is a *micromeric* one, having magnitudes of the various characters measured considerably smaller on an average than the general population, i.e. most of the characters are micrometropic. On the other hand, Paisley approximates to the general population in the magnitudes of its character means. Paisley males are slightly macrocranial, but distinctly dolichocephalic, their only distinguishing feature. Paisley females are hypsicranial. On the whole, the Paisley group is an *isomeric* one, the magnitudes of the characters of the group being mostly isometropic, or they are on the whole similar to the values found in the general population. The megalomeric populations are those of Argyll, Ayr, Montrose and Banff, while the distinctly micromeric populations are those of Glasgow (Gartloch, Lenzie and Govan). Isomeric populations occur at Dumfries, Fife, Haddington, Perth, Greenock and Paisley. All the other groups are *mictomeric.* By this is meant that the group possesses on an average greater or equal magnitudes of some characters, and equal or less in others—the characters are in part megalo-, micro-, and isometropic. With respect to the general population, the significant differences or deviations are both positive and negative; or comparatively speaking, the mictomeric groups have a mixed specification.

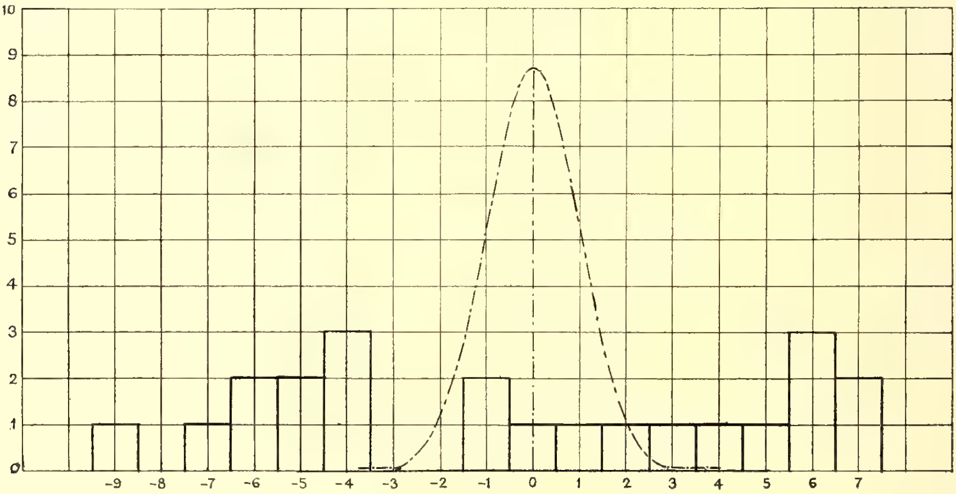
DIAGRAMS X. (*A* and *B*). Relative Local Differences of Means.—Head Heights.

Equation to Curve $y=\frac{22}{\sqrt{2\pi}}\cdot e^{-\frac{1}{2}x^2}$. The value of χ^2 is very large.

A. Males.



B. Females.



(4) *Variabilities and their Differences. Problem (d).*

Do the results for different parts of Scotland give any reason for supposing greater homogeneity or heterogeneity in one part than another? An endeavour can be made to answer this question after considering the variabilities in the distributions of the various characters. Under the character means, just dealt with, the sizes of the organs or characters were considered, differences in type noted, and the conclusion reached that the asylum population, as a whole, no matter what character is selected, is not a homogeneous one. An attempt will now be made to ascertain whether the separate district groups themselves can be described to be homogeneous; in other words, whether the groups in the various districts in Scotland are significantly more or less variable than the general asylum population.

If $\sigma =$ the standard deviation of any character at any asylum, and $\Sigma' =$ the standard deviation of the same character in the remaining population, then the ratio

$$(\sigma - \Sigma') \Big/ \sqrt{\left(\frac{\sigma^2}{2n} + \frac{\Sigma'^2}{2N'}\right)} = (RLD)\,\sigma$$

is the relative local difference in variability for any asylum. The values of this ratio for each character have been determined using the formula*

$$\sqrt{\left(\frac{\sigma^2}{2n} - \frac{\Sigma^2}{2N}\right)}$$

where $N = (n + N') =$ number in the whole population, in place of

$$\left[\frac{\Sigma^2}{2N} + \frac{\sigma^2}{2n}\left(1 - \frac{2n}{N}\right)\right]^{\frac{1}{2}},$$

Pearsons's full formula, which he shows to give the equivalent to

$$\left(\frac{\sigma^2}{2n} + \frac{\Sigma'^2}{2N'}\right)^{\frac{1}{2}}.$$

The foregoing shorter formula has been used, on the assumption, warrantable in the present series, that the ratio $\frac{\Sigma^2}{2N}$ differs from $\frac{\sigma^2}{2N}$ by a quantity so small that it may be put $= \frac{\sigma^2}{2N}$ without affecting the significance of the final result. In short, in this instance

$$\left(\frac{\sigma^2}{2n} - \frac{\Sigma^2}{2N}\right)^{\frac{1}{2}}$$

is a good approximation.

As expected, few districts show greater variability than the general population. Significantly greater variability occurs only in the character H among the Inverness males, and the Aberdeen and Montrose females. On the other hand, significantly low variability is exhibited by the male inmates at Ayr for all the cranial characters and by the females in head height only. The male and female inmates at Dundee, Argyll, Lenzie and Govan also show selection in head height, agreeing with Paisley, Greenock and Gartloch males and Perth, Dumfries and Fife females

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* Pearson, *Biometrika*, Vol. v. p. 183. The case considered in this note is the probable error of the difference between the mean of a subsample and the mean of a sample, but the same reasoning is applicable to the difference between the standard deviations of subsample and sample.

TABLE XII.

Relative local Differences of Variabilities.

	L	*B*	*H*	*B/L*	p_a	p_β	*S*
Males							
Aberdeen ...	-1·48	-2·38	-1·85	-1·60	-2·00	-2·11	- ·55
Dumfries ...	1·65	1·71	- ·83	1·57	1·70	·78	- ·66
Dundee ...	·67	- ·28	-5·03	·24	·20	-1·61	-1·56
Edinburgh ...	- ·87	- ·56	·01	- ·58	- ·83	- ·37	1·23
Montrose ...	·20	- ·91	1·01	- ·22	- ·34	·47	-2·13
Argyll ...	·53	·47	-3·68	·01	·77	- ·58	·20
Ayr	-3·46	-3·20	-2·19	-3·71	-3·10	-4·54	·12
Banff	- ·84	·43	- ·36	- ·03	- ·08	- ·17	·55
Elgin	-1·52	- ·20	·96	- ·58	- ·80	- ·19	·48
Fife	- ·32	-1·11	-2·30	- ·76	- ·69	-2·83	-5·80
Gartloch ...	-1·23	-1·00	-6·38	-1·15	-1·18	-3·14	·70
Lenzie ...	- ·14	1·00	-5·10	·77	·18	-1·88	1·77
Govan ...	- ·17	·74	-2·98	·25	·27	- ·97	1·44
Haddington ...	- ·63	·19	2·27	- ·09	- ·20	·89	·80
Inverness ...	-1·16	-2·34	4·18	-1·83	-1·65	1·00	-2·39
Lanark ...	-2·39	- ·86	-2·24	-1·65	-1·49	-1·49	-2·27
Midlothian ...	-1·45	1·30	- ·67	·46	·02	- ·08	-2·15
Perth	- ·01	- ·25	2·46	- ·11	- ·13	1·17	- ·34
Roxburgh ...	- ·32	- ·12	1·18	- ·20	- ·27	·43	-1·39
Stirling ...	+ ·67	·67	1·52	·64	·61	1·19	-1·00
Greenock ...	·36	1·36	-3·18	·93	·89	·61	1·18
Paisley ...	·69	-1·87	-5·82	- ·63	- ·50	1·96	·78
Females							
Aberdeen ...	2·15	·13	3·69	1·33	1·14	2·26	- ·49
Dumfries ...	·21	- ·05	-6·10	- ·02	-2·99	-1·96	-1·02
Dundee ...	·55	·34	-4·40	·53	·41	-1·33	-1·02
Edinburgh ...	-1·33	·79	- ·48	·03	- ·35	- ·26	- ·15
Montrose ...	- ·29	2·10	2·98	1·36	1·05	2·01	- ·31
Argyll ...	- ·22	-1·87	-5·78	-1·48	- ·88	-2·49	- ·16
Ayr	- ·10	1·75	-7·97	·73	·98	-1·84	·73
Banff	-1·66	-3·18	-1·11	-2·14	-2·33	-1·81	- ·04
Elgin	- ·12	- 26	- ·63	- ·01	- ·24	- ·59	- ·32
Fife	- ·17	·79	-2·99	·31	·39	- ·87	-2·84
Gartloch ...	- ·25	-1·21	-2·47	- ·74	- ·90	-1·81	1·14
Lenzie ...	-2·04	-3·47	-4·21	-2·90	-2·86	-3·44	-1·32
Govan ...	-1·04	-1·88	-6·35	-1·42	-1·57	-3·16	+ ·09
Haddington ...	- ·24	·33	- ·53	·02	·03	·00	·47
Inverness ...	- ·33	-2·91	·95	-1·60	-1·43	- ·59	- ·69
Lanark ...	- ·45	- ·41	-1·78	- ·58	- ·42	- ·81	·54
Midlothian ...	1·10	·03	1·22	·62	·48	·89	- ·42
Perth	·14	·17	-4·48	·16	·18	-1·07	-1·30
Roxburgh ...	-1·62	·25	1·34	- ·53	- ·66	·38	-1·19
Stirling ...	- ·82	- ·52	·75	- ·71	- ·70	·14	·64
Greenock ...	-1·98	·18	-2·52	- ·53	- ·88	-1·94	- ·86
Paisley ...	·46	- ·37	-1·36	·00	·09	·27	- ·84

in having low variability in the distribution of that character. The male and female inmates at Fife are a selected group with respect to stature, their variability being significantly less than that of the general population. The variabilities of the diametral product (*LBH*) among the male inmates at Ayr and Gartloch are significantly less than the general population, while the females at Lenzie and Govan are also significantly less. The variabilities for the remaining asylums approximate to the general mean with the exception of the females at Aberdeen and Montrose, which show for p_β, as they do for H, significantly greater variabilities than the general population. The accompanying table (Table XII.) shows the values of the relative local differences in variabilities. Maps and diagrams have also been prepared to illustrate this variability, but their reproduction has been considered unnecessary, the only facts of note being as just stated. The means and standard deviations of the differences, interlocally (shown in the table), measure (1) the fall in variability in passing from the general population to the individual groups for any one character, and (2) the amount of agreement, as to magnitude, among the differences themselves. It will be seen that H (♂ and ♀) has the greatest negative value among the means, and the greatest variability among the differences in passing from asylum to asylum.

So far as the question as to homogeneity or heterogeneity of district groups can be answered, it is answered in the following summary of differences probably significant.

TABLE XIII.

Variability Differences which are probably significant.

L		B		H		B/L		P_β		S	
Greater	Less	Greater	Less	Greater	Less	Greater	Less	Greater	Less	Greater	Less
	Ayr ♂		Ayr ♂ Inverness ♀ Banff ♀	Inverness ♂ Aberdeen ♀ Montrose ♀	Dundee, Argyll, Lenzie, Govan ♂ and ♀ Paisley ♂ Greenock ♂ Gartloch ♂ Perth ♀ Dumfries ♀ Fife ♀		Ayr ♂	Aberdeen ♀ Montrose ♀	Ayr ♂ Gartloch ♂ Lenzie ♀ Govan ♀		Fife ♂ and ♀

(5) *Differences between Male and Female Values of Coefficients of Variation.*

In the Supplement to this memoir (pp. 5—96) the values of the coefficients of variation for the various characters are given alongside the values of the means and standard deviations. In determining the differences between the values for males v_m and those for females v_f for each character at each of the asylums, the values of σ_v, the standard deviation of the coefficient of variation, were calculated from the usual formula

$$\sigma_v = \frac{v}{\sqrt{2n}}\left[1 + 2\left(\frac{v}{100}\right)^2\right]^{\frac{1}{2}}.$$

In the cases of B, B/L, and S,

$$\left[1 + 2\left(\frac{v}{100}\right)^2\right]^{\frac{1}{2}}$$

was taken equal to 1·002, a sufficiently near approximation.

The following table (Table XIV.) shows the values of

$$(v_m - v_f)/(\sigma_{v_m}{}^2 + \sigma_{v_f}{}^2)^{\frac{1}{2}}$$

for L, B, H, B/L and S for all the asylums. In the foregoing formula, $v_m =$ the coefficient of variation of any one character in any male group and $v_f =$ the coefficient of variation for the corresponding character in the corresponding female group.

TABLE XIV.

Relative Differences of Coefficients of Variation.

Males and Females.

Values of $(v_m - v_f)/(\sigma^2_{v_m} + \sigma^2_{vf})^{\frac{1}{2}}$.

Asylums	Head Length	Head Breadth	Head Height	Cephalic Index	Stature
Aberdeen ...	−1·84	− ·68	−4·04	−1·55	− ·34
Dumfries ...	1·50	1·95	2·51	1·56	·47
Dundee	·59	·19	− ·87	·15	− ·18
Edinburgh ...	·70	− ·25	·13	− ·10	1·29
Montrose ...	·79	−1·46	−2·21	− ·76	− ·76
Argyll	·91	2·16	·91	1·32	·47
Ayr	−1·67	−2·54	− ·26	−2·43	− ·07
Banff	·86	2·83	·43	1·75	·65
Elgin	− ·71	·46	·97	− ·18	·91
Fife	·42	− ·51	−2·62	− ·32	−1·16
Glasgow (Gartloch)	− ·06	1·06	−1·72	·31	− ·17
Do. (Lenzie)	2·09	4·00	− ·26	2·84	2·56
Govan	1·07	2·59	2·28	1·66	1·13
Haddington ...	·04	·30	2·18	·06	·44
Inverness ...	·06	1·34	1·86	·37	− ·51
Lanark	− ·57	·71	− ·61	− ·14	−1·25
Midlothian ...	−1·34	1·48	−1·51	·16	− ·92
Perth	·29	·31	4·46	·09	·97
Roxburgh ...	1·23	·36	− ·21	·51	·13
Stirling	1·59	1·69	·24	1·37	− ·76
Greenock ...	1·86	1·33	·07	1·34	1·46
Paisley	·48	− ·40	−2·47	− ·08	1·44
Totals ...	2·18	3·35	·96	1·71	1·39

Taking the series as a whole, we find the coefficients of variation in $B♂$ differ materially from $B♀$. On running through the values for the various asylums (see Table XIV.) this material difference is seen to be due to the inmates at Lenzie, where the sexual difference is very significant, and in a lesser degree to the inmates at Banff and Govan where the males also show greater relative variability, and at Ayr, where the females show the excess. In the other cases, the differences are not significant. The relative difference for L in the general population is perhaps hardly significant, but here again Lenzie stands out with a prominent difference. While the general coefficients for H are nearly equal, there are significant differences in the local values at Aberdeen and Perth and less significant ones at Fife, Paisley, Dumfries, Govan, Montrose and Haddington. Lenzie is again the disturbing factor in B/L and in S. The coefficients for B/L and S are approximately equal for most of the other asylums.

Thus, considering the differences between the sets of coefficients for both sexes at the individual asylums, we reach the conclusion that the variability among the males and females is very much alike, with the exception of the character B and a few local cases in the other characters. The conclusion is confirmed and amplified by considering the whole population where the males again appear more variable in B, the difference being probably significant, but in the other characters the variability among the males, although greater than among the females, is only slightly greater, and cannot be said to be at all significant.

(6) *Pigmentation.*

I. *Distribution of Hair and Eye Colour.* As already stated, the colours of the hair and eyes of most of the inmates were noted at the same time that the measurements were taken. A complete record of the observations is given in the Supplement to this memoir side by side with the record of observations on measurable characters.

In order to make a comparison between the pigmentation of the inmates at each asylum and the pigmentation of the "general insane" population, the values of χ^2 and $\log P$* were calculated for each asylum. In other words the actual frequencies for each colour were contrasted with their most probable values—the theoretical numbers which would occur on an even distribution of the "general insane" population. The approximate values of $\log P$ are given in Table XV. and XVI. and show that with the exception of a few cases, the local pigmentation diverges in character from the general distribution considerably. It is of interest to note that the divergence in colour of any locality from the remaining population may be measured by determining the mean square contingency coefficient

$$C_1 = \sqrt{\frac{\chi'^2/N}{1+\chi'^2/N}},$$

where χ'^2 = the total square contingency†. Thus, to take a particular case, the distribution of hair colour in males at Aberdeen may be contrasted with the remaining population as in Table XVII. We find $C_1 = \cdot 1347$.

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* Elderton: *Biometrika*, Vol. I. p. 155, χ^2 of Goodness of Fit.

† Pearson: *Drapers' Company Research Memoirs*, Biometric Series, I. p. 16.

TABLE XV. *Divergency in Hair Colour.*

Asylums	Males		Females	
	Log *P*	*Q*	Log *P*	*Q*
Aberdeen	$\overline{16}\cdot8$	·135	$\overline{28}\cdot3$	·186
Dumfries	$\overline{6}\cdot9$	·080	$\overline{6}\cdot8$	·085
Dundee	$\overline{5}\cdot7$	·074	$\overline{4}\cdot9$	·067
Edinburgh	$\overline{1}\cdot1$	·038	$\overline{3}\cdot0$	·066
Montrose	$\overline{51}\cdot3$	·238	$\overline{6}\cdot5$	·087
Argyll	$\overline{16}\cdot1$	·137	$\overline{10}\cdot5$	·115
Ayr	$\overline{6}\cdot7$	·083	$\overline{12}\cdot0$	·125
Banff	$\overline{6}\cdot2$	·085	$\overline{2}\cdot9$	·043
Elgin	$\overline{10}\cdot4$	·107	$\overline{13}\cdot6$	·127
Fife	$\overline{9}\cdot9$	·100	$\overline{7}\cdot5$	·094
Gartloch	$\overline{8}\cdot4$	·098	$\overline{6}\cdot2$	·089
Lenzie	$\overline{3}\cdot2$	·062	$\overline{1}\cdot1$	·041
Govan	$\overline{9}\cdot6$	·102	$\overline{2}\cdot0$	·055
Haddington	$\overline{1}\cdot8$	·021	$\overline{1}\cdot6$	·029
Inverness	$\overline{26}\cdot7$	·171	$\overline{19}\cdot7$	·153
Lanark	$\overline{1}\cdot4$	·033	$\overline{1}\cdot0$	·041
Midlothian	$\overline{2}\cdot9$	·040	$\overline{4}\cdot7$	·069
Perth	$\overline{13}\cdot5$	·122	$\overline{2}\cdot9$	·043
Roxburgh	$\overline{1}\cdot7$	·025	$\overline{1}\cdot8$	·023
Stirling	$\overline{10}\cdot3$	·110	$\overline{7}\cdot1$	·097
Greenock	$\overline{3}\cdot2$	·062	$\overline{2}\cdot0$	·056
Paisley	$\overline{4}\cdot9$	·063	$\overline{3}\cdot1$	·066

TABLE XVI. *Divergency in Eye Colour.*

Asylums	Males		Females	
	Log *P*	*Q*	Log *P*	*Q*
Aberdeen	$\overline{9}\cdot1$	·101	$\overline{11}\cdot5$	·117
Dumfries	$\overline{4}\cdot3$	·064	$\overline{4}\cdot6$	·066
Dundee	$\overline{5}\cdot9$	·068	$\overline{2}\cdot6$	·043
Edinburgh	$\overline{4}\cdot7$	·061	$\overline{4}\cdot9$	·064
Montrose	$\overline{5}\cdot1$	·075	$\overline{10}\cdot8$	·108
Argyll	$\overline{1}\cdot6$	·021	$\overline{1}\cdot99$	·003
Ayr	$\overline{2}\cdot7$	·039	$\overline{5}\cdot2$	·080
Banff	$\overline{18}\cdot7$	·137	$\overline{9}\cdot4$	·104
Elgin	$\overline{15}\cdot8$	·124	$\overline{14}\cdot0$	·132
Fife	$\overline{3}\cdot9$	·049	$\overline{3}\cdot4$	·059
Gartloch	$\overline{2}\cdot0$	·048	$\overline{3}\cdot8$	·053
Lenzie	$\overline{6}\cdot0$	·085	$\overline{2}\cdot3$	·047
Govan	$\overline{2}\cdot0$	·048	$\overline{5}\cdot3$	·078
Haddington	$\overline{5}\cdot6$	·070	$\overline{1}\cdot96$	·008
Inverness	$\overline{36}\cdot9$	·197	$\overline{16}\cdot8$	·140
Lanark	$\overline{5}\cdot7$	·071	$\overline{4}\cdot4$	·070
Midlothian	$\overline{5}\cdot8$	·069	$\overline{1}\cdot6$	·023
Perth	$\overline{11}\cdot9$	·106	$\overline{5}\cdot2$	·075
Roxburgh	$\overline{7}\cdot9$	·083	$\overline{3}\cdot9$	·052
Stirling	$\overline{2}\cdot7$	·040	$\overline{7}\cdot8$	·091
Greenock	$\overline{1}\cdot4$	·026	$\overline{1}\cdot9$	·011
Paisley	$\overline{1}\cdot6$	·021	$\overline{1}\cdot6$	·023

TABLE XVII.

Males	Red	Fair	Medium	Dark	Totals
Aberdeen	8	16	78	132	234
Remaining Population ...	58	259	2444	1240	4001
Totals	66	275	2522	1372	4235

In a private communication* Professor Pearson gives the following equivalent formula in terms of χ^2, and thus obviates the necessity of determining each χ'^2. If N = number in the general population and n = number in any locality;

$$C_1 = Q = \sqrt{\frac{\chi^2}{N - n + \chi^2}},$$

the measure of the divergence of the local group from the remaining population. Thus $\chi^2 = \chi'^2 (1 - n/N)$, and Q, the divergency coefficient, is determined directly from χ^2. The values of Q are given alongside those of $\log P$ in Tables XV. and XVI. Both sets of values are approximations, sufficiently correct to enable their significance to be seen on inspection. Their relationship is shown in Diagram XI. All values of $\log P > \bar{3}$ (and thus, in this series, of $Q > \cdot 055$) are probably significant. A reference to the tables and to the colour divergency maps (where the values of Q and $\log P$ have been classed) will show that the south east of Scotland is like the general population in hair colour (♂ and ♀) and eye colour (♀). Argyll, Ayr, Stirling and Fife, all contiguous, are least divergent among the males in eye colour. Generally speaking, the populous centres and environs are very like the general population, while in the sparsely populated parts the divergencies are the greatest.

Coming now to the cause of the divergencies (the excess frequencies of one or other of the various categories), the significance or non-significance of the various frequencies was determined in the following manner. Let y_s = total number of inmates in Scotland possessing any particular hair or eye colour; N = total number of inmates; m = number of inmates at any asylum, then $m/N\ y_s = y_s'$, the expected frequency. Let y_s'' = the corresponding observed frequency; $y_s/N = p$; $1 - p = q$; then $(y_s'' - y_s')/\sqrt{mpq\,(N - m)/(N - 1)}$ = the difference between the observed and the expected frequency relative to the standard deviation of y_s'' in the sample, m, of the population. The values of this rate for each category have been determined.

It has been recently shown by Pearson† that, in a population of N individuals, Np of which possess a given character, and Nq do not, the distribution of frequency in the character for random samples of magnitude m (when m is commensurable

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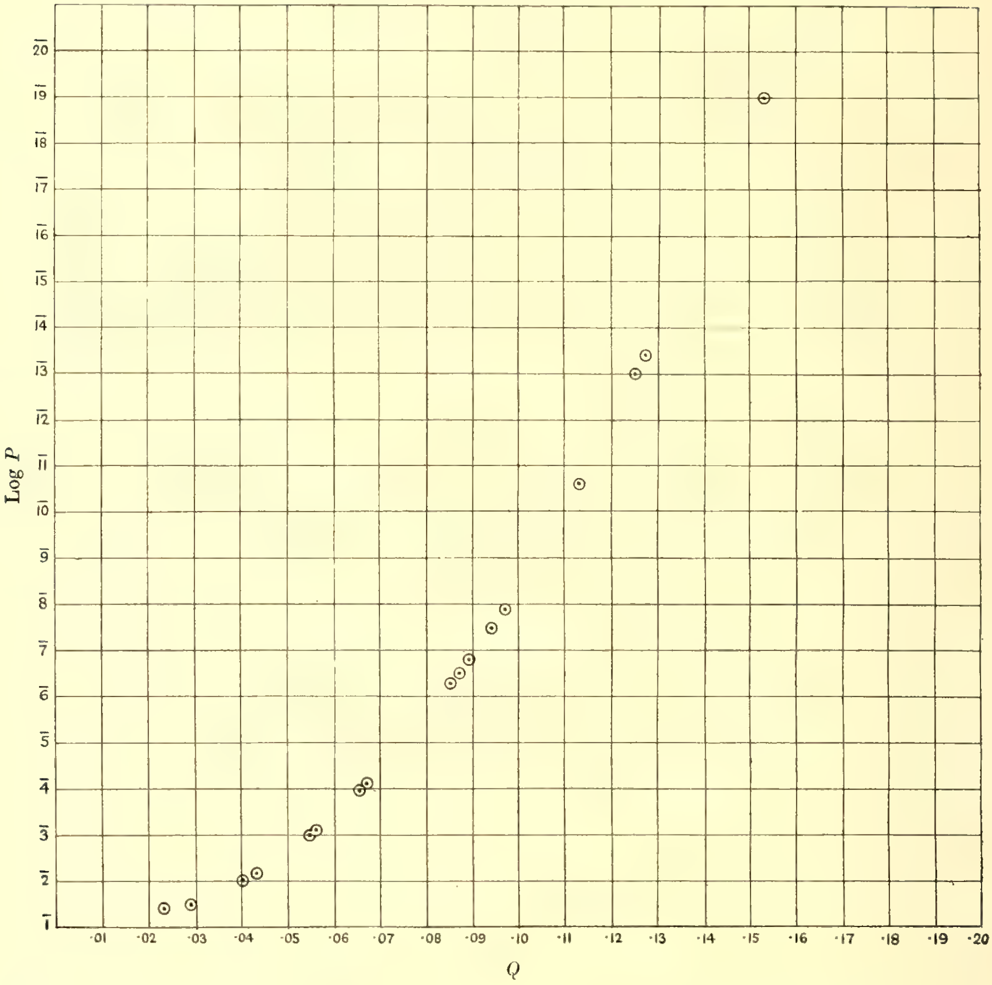
* Since published. *Biometrika*, Vol. v. pp. 198—203.

† *Biometrika*, Vol. v. pp. 172—175.

Diagram XI. Relationship between Q and Log P.—Hair Colour, Females.



with N) is not a symmetrical one, but can be accurately described by a skew curve of either Type I. or Type IV. Thus, he points out that the tables of the probability integral cannot accurately give the areas on either side of the ordinate which divides the curve at the abscissal value $(y_s'' - y_s')/\sqrt{mpq\,(N-m)/(N-1)}$, and the probability of greater or lesser values occurring in future samples must be determined by other means. Since however the values of $(m-1)/(N-1)$ in the present series are small (although not quite negligible), an approximate estimate of the significance of each difference can be obtained by determining the values of the ratio $(y_s' - y_s')/\sqrt{mpq}$, the distribution of these relative differences being assumed to follow the normal curve. The relative differences themselves are thus, on this basis, the abscissal values of the normal curve $y = 1/\sqrt{2\pi}\,.\,e^{-\frac{1}{2}x^2}$. The ratios $(y_s' - y_s')/\sqrt{mpq\,(N-m)/(N-1)}$ and $(y_s' - y_s')/\sqrt{mpq}$ have both been calculated for the present series of observations on hair and eye colours, the values of the latter ratio being given in Tables XVIII. and XIX. The values of the factor $\beta = 1/\sqrt{1-(m-1)/(N-1)}$ are also given in the tables, and these, if multiplied by the values of the relative local differences in the tables provide the corresponding values of $(y_s' - y_s')/\sqrt{mpq\,(N-m)/(N-1)}$ for comparative purposes.

Applying the foregoing test to all the hair and eye categories, it is found that Scotland north of the Forth is quite significantly darker than the south. Excepting Dundee, Fife and Argyll, which have a significant excess of medium hair, the country north of the Forth is significantly dark haired. The whole of the south-west is significantly brown haired, while a significant excess of fair occurs in the Stirling group (♀) and in Stirling, Perth and Montrose groups (♂). North of the Grampians there is a significant excess of red hair among the females and possibly also among the males, although Aberdeen is the only group which shows definite significance. Turning now to eye colour we see that north of the Grampians there is a significant excess of medium eyes, south of

TABLE XVIII.

Relative Local Differences in Hair and Eye Colours.

Asylums	Males							Values of $\beta=1\Big/\sqrt{1-\left(\frac{m-1}{N-1}\right)}$
	Hair				Eyes			
	Red	Fair	Medium	Dark	Light	Medium	Dark	
Aberdeen ...	2·39	·22	−6·51	7·85	−5·41	6·09	−·39	1·029
Dumfries ...	−1·40	−1·27	5·13	−4·34	4·01	−1·78	−2·79	1·014
Dundee ...	−·82	−·31	4·60	−4·45	3·85	−·86	−3·63	1·017
Edinburgh ...	·74	1·89	−1·94	·85	1·89	−3·81	2·03	1·022
Montrose ...	·59	14·58	−9·52	2·16	−4·37	1·27	3·78	1·031
Argyll ...	−·59	−3·63	8·70	−8·06	·38	·77	−1·33	1·023
Ayr ...	−·90	−1·63	6·34	−4·41	2·01	−·14	−2·24	1·029
Banff ...	−·11	−2·16	−3·71	5·30	−6·94	8·63	−1·18	1·008
Elgin ...	·22	−1·54	−5·83	6·36	−6·58	7·67	−·52	1·007
Fife ...	−1·34	−1·34	6·31	−5·57	3·04	−1·53	−1·94	1·026
Gartloch ...	−1·77	−·51	5·97	−5·55	1·68	−3·01	1·37	1·037
Lenzie ...	−·78	−2·97	3·29	−1·69	−·49	−3·77	4·93	1·047
Govan ...	−·07	−3·29	6·28	−4·84	2·79	−2·68	−·36	1·033
Haddington	−·11	−·69	·87	−·27	4·25	−2·89	−2·11	1·008
Inverness ...	·38	−1·63	−9·67	10·91	−9·74	12·42	−2·13	1·026
Lanark ...	·43	−1·86	−·24	1·12	4·16	−3·76	−·78	1·049
Midlothian ...	·67	2·24	−1·80	·54	4·27	−2·85	−2·04	1·016
Perth ...	·87	3·73	−7·70	5·89	−5·94	1·40	5·68	1·021
Roxburgh ...	−·11	·36	1·36	−1·58	5·15	−3·09	−2·85	1·017
Stirling ...	1·55	2·59	−6·90	5·48	−1·99	·14	2·24	1·038
Greenock ...	−·65	−2·86	3·51	−2·01	1·61	−1·08	−·77	1·014
Paisley ...	·48	−2·54	3·72	−2·69	1·24	−·52	−·96	1·011
$(s-1)$	−·03	2·75	4·57	3·98	3·35	3·38	1·51	—

the Forth significant excess of light eyes, while Lenzie and the regions of Perth, Montrose, Edinburgh and Stirling are significantly dark eyed. Summarising the results of colour observations generally, it is found that, compared with the "general insane" population, the north of Scotland has excess of medium eyes, dark and red hair, the south-east is light eyed, the south-west brown haired and light eyed, while the midlands are mixed in character, having not only an excess of fair medium and dark hair but also of light and dark eyes. Considered inter-locally, the non-measurable characters red hair ♂, fair hair ♀ and dark eyes ♀ do not show significant departures from homogeneity [see values of $(s-1)$, Tables XVIII. and XIX.]. The other colour characters show great heterogeneity inter-locally. Thus the same conclusion is reached for non-measurable characters as was reached for measurable characters, namely: *Individual asylum groups cannot be said to form part of a "general insane" population of a homogeneous character.*

For a detailed examination of the pigmentation of the inmates the reader is referred to Tables XVIII. and XIX. and to the pigmentation maps, Maps XIII. to

TABLE XIX.

Relative Local Differences in Hair and Eye Colours.

Asylums	Females							Values of $\beta=1\Big/\sqrt{1-\left(\frac{m-1}{N-1}\right)}$
	Hair				Eyes			
	Red	Fair	Medium	Dark	Light	Medium	Dark	
Aberdeen	7·48	·72	−9·84	7·41	−6·72	5·33	1·68	1·030
Dumfries	−1·34	·92	4·85	−4·82	3·91	−2·60	−1·52	1·020
Dundee	−2·21	·53	3·58	−3·13	2·39	− ·72	−1·86	1·028
Edinburgh	− ·42	·03	−3·79	3·97	3·17	−3·51	·29	1·029
Montrose	2·22	− ·02	−5·07	4·46	−5·39	6·09	− ·61	1·014
Argyll	−2·19	− ·28	6·71	−6·03	− ·06	·18	− ·13	1·027
Ayr	−2·04	−1·18	7·64	−6·72	6·04	−2·70	−2·32	1·035
Banff	·76	− ·36	−2·45	2·37	−5·01	6·02	− ·96	1·007
Elgin	5·77	·73	−6·13	4·18	−5·90	7·88	−1·98	1·009
Fife	−1·82	− ·84	5·66	−4·89	3·20	−2·95	− ·35	1·029
Gartloch	−1·47	1·11	5·02	−5·02	3·11	−2·27	− ·99	1·022
Lenzie	−1·86	−1·48	·92	·16	− ·40	−1·99	2·59	1·040
Govan	−1·18	−1·04	3·27	−2·60	3·84	−3·37	·47	1·026
Haddington	·17	−1·48	1·15	− ·71	·04	− ·39	·38	1·010
Inverness	5·05	·71	5·71	6·96	−6·99	7·81	− ·69	1·026
Lanark	−1·93	−1·37	− ·05	1·11	3·79	−3·40	− ·52	1·019
Midlothian	− ·23	−1·05	−3·69	4·18	1·32	− ·55	− ·86	1·020
Perth	·27	1·10	−2·52	2·09	−4·70	2·64	2·35	1·015
Roxburgh	− ·71	·99	− ·29	·85	2·81	−2·71	− ·18	1·019
Stirling	1·29	3·00	−5·54	4·20	−5·08	1·59	3·90	1·035
Greenock	−1·57	·07	3·18	−2·76	·01	− ·55	·58	1·014
Paisley	− ·82	2·08	2·96	−3·46	1·10	·04	−1·26	1·013
$(s-1)$	1·66	·17	3·73	3·23	3·03	2·75	·53	—

XVIII. the relative values being given in all cases in the tables*. The percentages are given in Tables XXIII. and XXIV. of Supplement.

II. *Correlation of Hair and Eye Colour.* Applying the contingency method to the data (see Table VIII. of Supplement) the following results were obtained. The author's results from the Aberdeenshire population and those of Pearson from Continental and British returns are also given, for the sake of comparison.

TABLE XX.

Correlation.—Hair and Eyes.

Population	Contingency Coefficient	Returns by
Male Asylum Inmates ...	·3039	J. F. Tocher
Female Asylum Inmates ...	·2994	"
Adult Scottish Population ...	·3673	"
Scottish Children †	·3802	"
Swedish Conscripts ‡ ...	·2495	G. Retzius
Prussian Children ‡	·2714	R. Virchow
Italian Conscripts ‡	·3091	R. Livi
Jewish Children ‡	·3381	R. Virchow
Baden Conscripts ‡	·3540	O. Ammon
British Schoolboys ‡	·4203	K. Pearson

From this we see that there is no material difference between sane and insane populations in their degrees of correlation between hair and eye colours, although the result for the Scottish sane population is higher. The degree of correlation in the case of the Scottish children is slightly higher than that of the adult Scottish sane population. The continental results given above are not directly comparable, since while the children's data are available, those of the corresponding adult populations are wanting, and besides there are racial differences to consider. It would seem, however, from the foregoing that the correlation between hair and eye colours decreases in passing from a juvenile to an adult population. This is obviously due to a change of hair and eye colours in passing from childhood to manhood. The correlation between age and the colour of hair and eyes in man has been dealt with by Pearson§, who shows from Uchida's results on Prussian and British data that, with a range of 13 years (7–19), the correlation between age and hair colour amounts to ·158, and between age and eye colour ·096. From Pfitzner's hospital results the value ·451 was obtained for hair colour and age, but it is pointed out that, owing to the positive correlation between fairness and disease in childhood, this value is too high; probably ·2 to ·25 would

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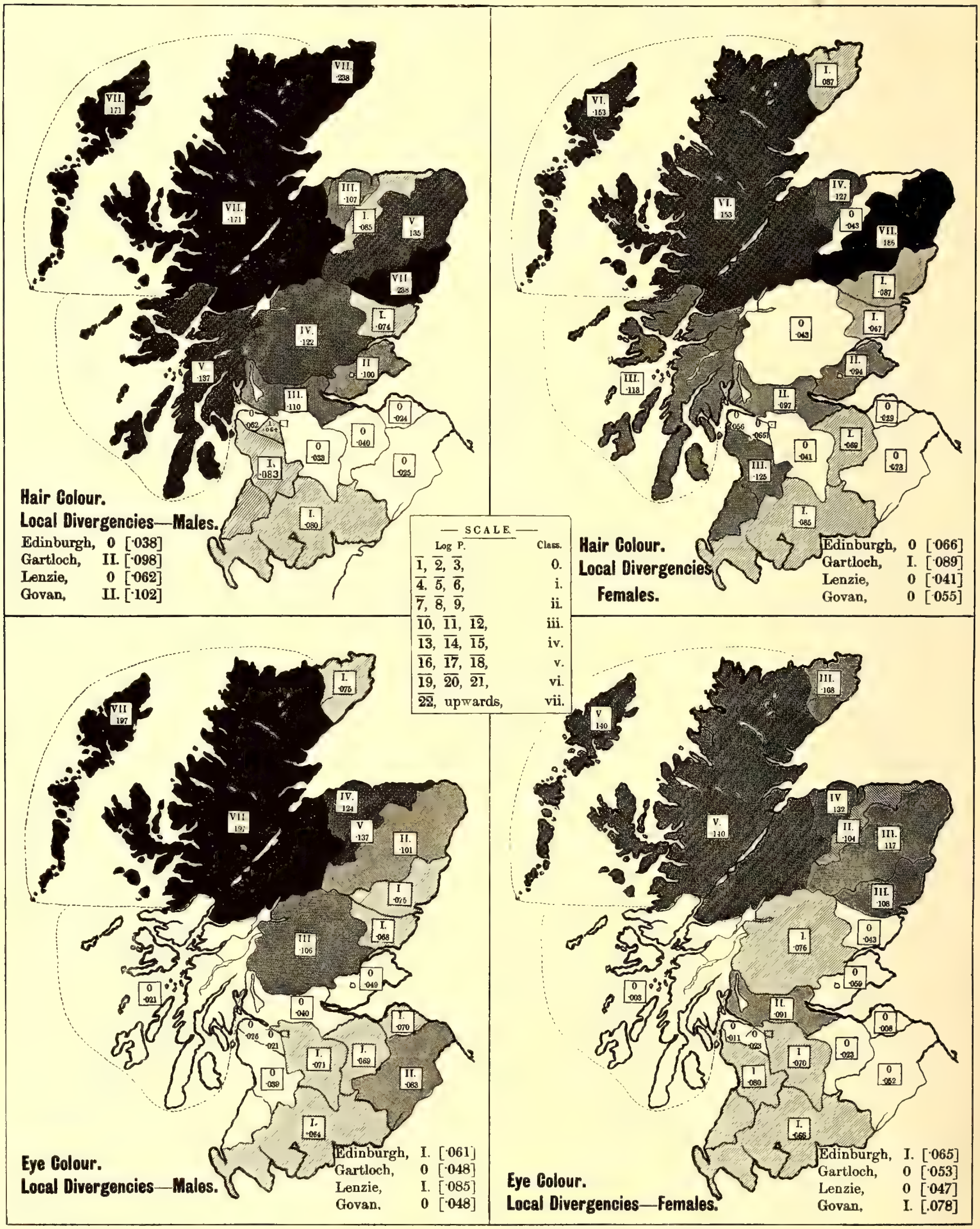
* The foregoing is a short summary of the colour characteristics of the inmates. They will be dealt with in more detail in another paper when the results will be compared with the results of the Pigmentation Survey of Scottish School Children just carried out by the writer.

† Not yet published.

‡ Pearson: *Biometrika*, Vol. III. p. 461.

§ *Biometrika*, Vol. III. pp. 462—466.

Map XIII. Map XIV.


VII. ·238
VII. ·171
VII. ·171
III. ·107
I. ·085
V ·135
VII ·238
I. ·074
IV. ·122
V ·137
II ·100
III. ·110
0 ·024
0 ·062
I. ·064
0 ·040
0 ·033
I. ·083
0 ·025
I. ·080
I. ·087
VI. ·163
IV. ·127
0 ·043
VI. ·153
VII. ·186
I. ·087
0 ·043
I. ·067
III. ·118
II. ·094
II. ·097
0 ·029
0 ·056
0 ·065
0 ·041
I. ·069
III. ·125
0 ·023
I. ·085
I. ·075
VII ·197
IV. ·124
VII. ·197
V ·137
II. ·101
I ·076
III ·106
I. ·068
0 ·021
0 ·049
0 ·040
I. ·070
0 ·026
0 ·021
I. ·071
I. ·069
0 ·039
II. ·083
I. ·064
III. ·108
V ·140
IV ·132
V. ·140
II. ·104
III. ·117
III. ·108
I. ·076
0 ·043
0 ·003
0 ·059
II. ·091
0 ·008
0 ·011
0 ·023
I ·070
0 ·023
I ·080
0 ·052
I. ·066

Hair Colour.
Local Divergencies—Males.

Edinburgh,	0	[·038]
Gartloch,	II.	[·098]
Lenzie,	0	[·062]
Govan,	II.	[·102]

Hair Colour.
Local Divergencies—Females.

Edinburgh,	0	[·066]
Gartloch,	I.	[·089]
Lenzie,	0	[·041]
Govan,	0	[·055]

— SCALE. —

Log P.	Class.
$\overline{1}$, $\overline{2}$, $\overline{3}$,	0.
$\overline{4}$, $\overline{5}$, $\overline{6}$,	i.
$\overline{7}$, $\overline{8}$, $\overline{9}$,	ii.
$\overline{10}$, $\overline{11}$, $\overline{12}$,	iii.
$\overline{13}$, $\overline{14}$, $\overline{15}$,	iv.
$\overline{16}$, $\overline{17}$, $\overline{18}$,	v.
$\overline{19}$, $\overline{20}$, $\overline{21}$,	vi.
$\overline{22}$, upwards,	vii.

Eye Colour.
Local Divergencies—Males.

Edinburgh,	I.	[·061]
Gartloch,	0	[·048]
Lenzie,	I.	[·085]
Govan,	0	[·048]

Eye Colour.
Local Divergencies—Females.

Edinburgh,	I.	[·065]
Gartloch,	0	[·053]
Lenzie,	0	[·047]
Govan,	I.	[·078]

Map XV. Map XVI.

be about the correct value. No British adult data are at present available to determine the constants involved. The change, however, in passing from juveniles (under 19) to adults can be approximately measured from the Aberdeenshire data. With the figures given in the following table, $r = \cdot 24$, when we use Pearson's fourfold table method for characters not quantitatively measurable*.

TABLE XXI. *Correlation of Age and Hair Colour.*

	Red	Fair	Medium	Dark	Totals
Adults ...	8	71	133	189	401
Children ...	28·1	100·2	188·5	84·2	401
Totals ...	36·1	171·2	321·5	273·2	802

III. *Distribution of Colour among the Sane and the Insane.* Since the Aberdeen data represent a local group, the colour observations on adults there cannot be contrasted with the colour data of the "general insane" population, as local groups may or may not be good samples of the general population. It has been shown for all characters that they are more likely not to be good samples. The rate of change of hair and eye colour with age, however, is not so likely to vary in passing from one district to another. On the assumption that the rate of change is fairly uniform throughout Scotland, an approximate estimate can be made as to the probable distribution of hair and eye colours among the adult sane population from the Aberdeenshire data and the results of the observations from the Pigmentation Survey of School Children in Scotland about to be published. Let $p_1, p_2, \dots p_n =$ percentage of either hair or eye colour among school children in any district; $q_1, q_2, \dots q_n =$ similar percentages among the adults in the same district; $p'_1, p'_2, \dots p'_n =$ similar percentages among the children in the entire school population; $R = (1 + \epsilon/(100 - \epsilon))$; $\epsilon =$ a constant whose value depends on the nature of the distribution and $n =$ number of categories then

$$\frac{p'_1 q_1 R}{p_1} + \frac{p'_2 q_2 R}{p_2} + \frac{p'_3 q_3 R}{p_3} \dots + \frac{p'_n q_n R}{p_n} = 100,$$

and gives the corresponding probable percentages of either hair or eye colour in the general adult sane population of the country. Applying this equation to the Scottish normal data, we obtain the following values, the corresponding values for the "general insane" population being given for comparison.

To judge from this result—a tentative one—there is an excess of light-eyed, brown and dark-haired persons in Scottish asylums and a corresponding defect in the other categories. The colour distributions of the "general insane" population cannot therefore be held to be fair samples of the general population of Scotland.

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* It is assumed that selection by hair-colour does not occur; the children are the distributions of 401 individuals on the base of the Pigmentation Survey, for Aberdeenshire; the division is taken between 'fair' and 'medium.'

TABLE XXII. *Pigmentation of Sane and Insane.*

	Hair per cent.				Eyes per cent.		
	Red	Fair	Medium	Dark	Light	Medium	Dark
Probable distribution of adult Sane Population	4·2	11·5	55·9	28·4	27·8	45·9	26·3
General Insane Population	1·6	6·5	59·5	32·4	45·0	32·6	22·4
Difference	2·6	5·0	−3·6	−4·0	−17·2	13·3	3·9

IV. *Relationship between Colour and Insanity.* This problem can be viewed from another standpoint, without dealing either with the observed colour distributions among the insane or the estimated values among the sane, just discussed. The various proportions of the insane among the whole population in each of the various districts in Scotland can be compared with the corresponding proportions of children possessing any particular hair or eye colour within the same areas. In the Report on the Scottish Census of 1901*, the proportion of lunatics per million of the population in each county and in the eight chief divisions of Scotland are given. From the results of the Pigmentation Survey of Scottish School Children recently carried out by the writer, the proportional colour distributions within the same areas can be found. Taking light-eyed children as an example the following table (XXIII.) was formed, x_1 being the deviation from the mean percentage of light-eyed children, and x_2 the corresponding deviation from the mean proportion of insane in the eight divisions under consideration.

TABLE XXIII.

Division	x_1	x_2
I	−1·99	−2735
II	− ·20	+ 816
III	− ·38	− 206
IV	−1·31	+ 553
V	+1·94	+2431
VI	+ ·15	−1549
VII	+ ·51	−1084
VIII	+1·31	+1772

The following values of r and of the ratio of r to its probable error E_r were obtained by comparing the percentages of the various colours successively with the proportion of insane in the eight divisions of Scotland. (Table XXIV.)

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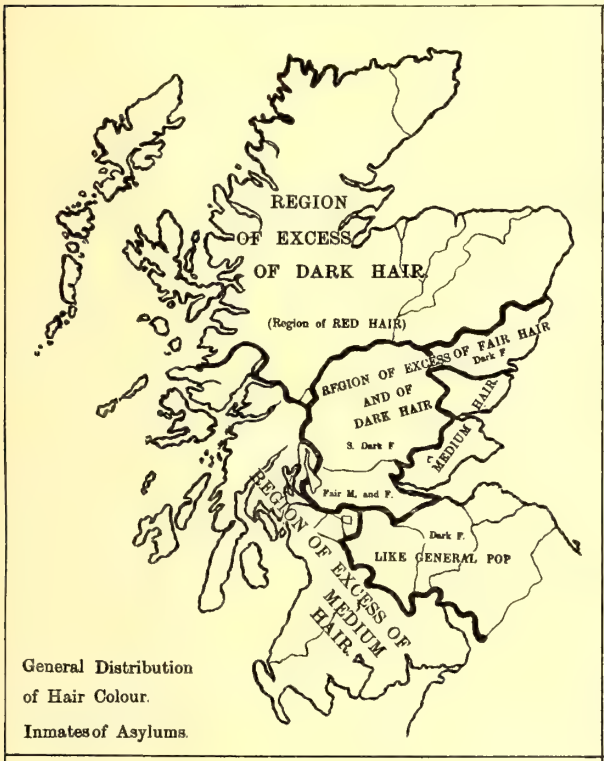
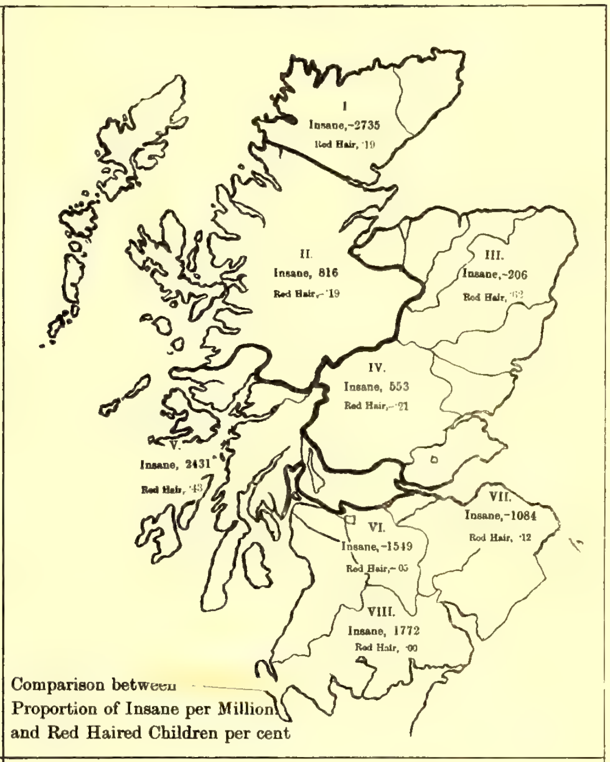
* Eleventh Decennial Census of the Population of Scotland, 1901, with Report, Vol. I. Table XVII, page xxix.

Map XVII.

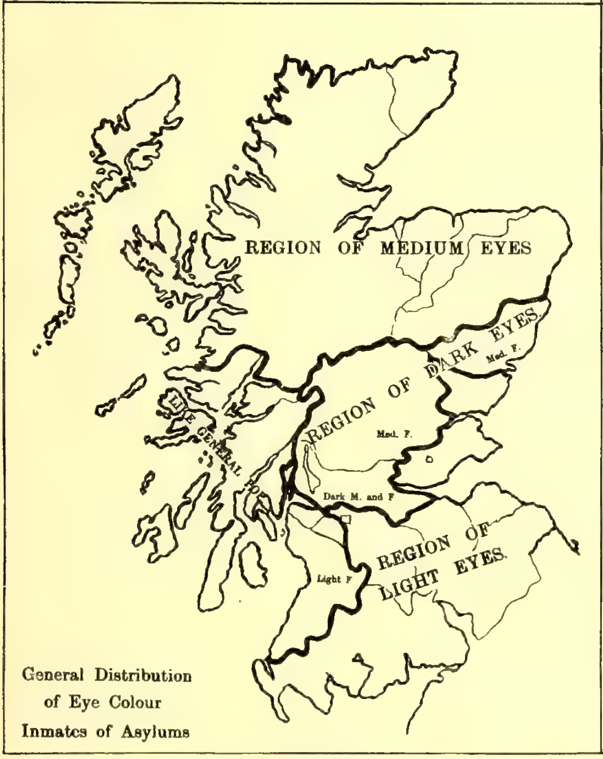

REGION OF EXCESS OF DARK HAIR
(Region of RED HAIR)
REGION OF EXCESS OF FAIR HAIR
Dark F
REGION OF EXCESS AND OF DARK HAIR
MEDIUM HAIR
S. Dark F
Fair M. and F.
REGION OF EXCESS OF MEDIUM HAIR
Dark F.
LIKE GENERAL POP

General Distribution
of Hair Colour.
Inmates of Asylums.

Map XIX.

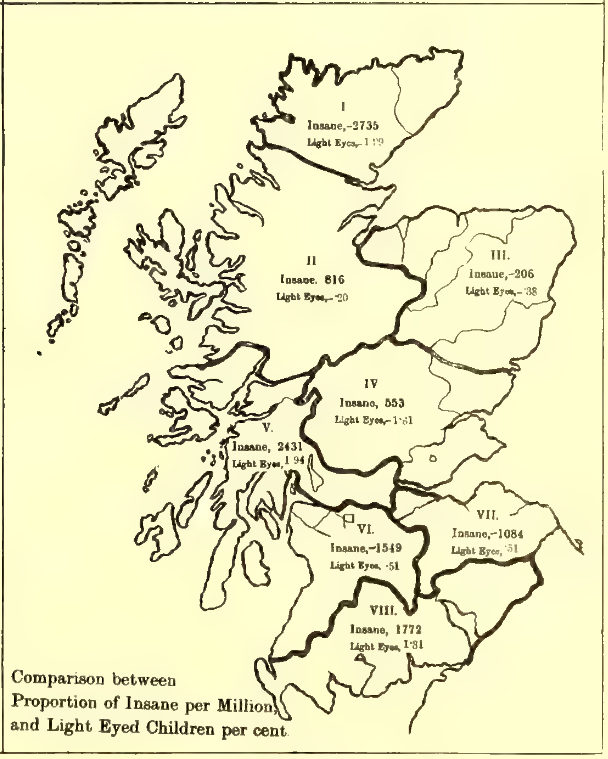

I
Insane,-2735
Red Hair, ·19
II.
Insane, 816
Red Hair,-·19
III.
Insane,-206
Red Hair, ·62
IV.
Insane, 553
Red Hair,-·21
V.
Insane, 2431
Red Hair, ·43
VI.
Insane,-1549
Red Hair,-·05
VII.
Insane,-1084
Red Hair, ·12
VIII.
Insane, 1772
Red Hair, ·00

Comparison between
Proportion of Insane per Million
and Red Haired Children per cent


REGION OF MEDIUM EYES
REGION OF DARK EYES
Med. F.
Med. F.
LIKE GENERAL POP.
Dark M. and F
REGION OF LIGHT EYES
Light F

General Distribution
of Eye Colour
Inmates of Asylums

Map XVIII.


I
Insane,-2735
Light Eyes,-1·29
II
Insane. 816
Light Eyes,-·20
III.
Insane,-206
Light Eyes,-·38
IV
Insane, 553
Light Eyes,-1·81
V.
Insane, 2431
Light Eyes, 1·94
VI.
Insane,-1549
Light Eyes, ·51
VII.
Insane,-1084
Light Eyes, ·51
VIII.
Insane, 1772
Light Eyes, 1·31

Comparison between
Proportion of Insane per Million
and Light Eyed Children per cent.

Map XX.

TABLE XXIV. *Correlation.—Hair and Eye Colours with Lunacy.*

Colour	r	$\frac{r}{E_r}$
Red Hair	− ·5824	3·70
Fair Hair	− ·0244	·10
Medium Hair	− ·1283	·55
Dark Hair	·3396	1·61
Jet Black Hair	·0836	·35
Light Eyes	·6952	5·64
Blue Eyes	− ·0719	·30
Medium Eyes	− ·3222	1·51
Dark Eyes	− ·4815	2·63

The results in the above table appear to be important, and confirm the deductions made from the pigmentation of the inmates. They show that on an average more persons became insane in parts of the country where there is an excess of light-eyed persons in the population, and in a much less degree where there is an excess of dark-haired persons. Lunacy is distinctly correlated positively to light eyes and in a much less degree to dark hair; and is distinctly correlated negatively to red hair and in a lesser degree to dark eyes. Thus there is a greater tendency to insanity among light-eyed and dark-haired persons, and a lesser tendency to insanity among red-haired and dark-eyed persons, compared in both cases with the general population. These are merely statistical facts, and no explanation is offered as to how or why presence or absence of pigment comes to be associated, as it is here found to be, with insanity.

(7) *Comparison with other Data.*

I. *General.* As has already been stated, no general Scottish data exist which can be directly compared with the Scottish "general insane" population, since a general survey of Scotland has not yet been carried out. Such British returns as are available can, however, be contrasted with the data under discussion. The following table shows the values of the means of L, B, and 100 B/L.

TABLE XXV. *Comparative Table of* L, B, *and* 100 B/L.

Population	Measurement on	L (mm)	B (mm)	$100\frac{B}{L}$	Reference
General Hospital ...	Head	190·4	149·3	78·5	*Biometrika*, Vol. IV. p. 126, Blakeman
English Criminals ...	,,	191·7	150·4	77·2	*Biometrika*, Vol. I. p. 204, Macdonell
Cambridge Graduates ...	,,	193·5	154·0	79·6	*Biometrika*, Vol. I. p. 351, Pearson
Scottish Lunatic Pop. ...	,,	195·5	151·5	77·6	This Memoir
Scottish Habitual Crim.	,,	196·3	153·1	78·0	This Memoir
British Association ...	,,	198·1	155·5	78·2	*Phil. Trans.* Vol. 196 A. Lee and Pearson
Naqada Crania ...	Cranium	185·1	134·9	73·0	*Biometrika*, Vol. I. p. 438, Fawcett
Long Barrow Skulls ...	,,	190·6	142·5	74·9	*Biometrika*, Vol. IV. p. 354, Schuster
English Crania ...	,,	189·1	140·7	74·3	*Biometrika*, Vol. III. p. 208, Macdonell
Scottish Crania ...	,,	186·8	144·3	77·3	*R. S. E.* Vol. 40, Part III. Sir W. Turner

II. *Scottish Criminals.* The writer is indebted to Dr J. F. Sutherland, Assistant Scottish Lunacy Commissioner, for kindly supplying the measurements on 375 Scottish habitual criminals. The analysis of these observations has provided interesting results. The criminals were divided into four classes; those convicted of (I) robbery and assault, (II) theft, (III) murder and assault, and (IV) offences against chastity. The following table gives the results of the analysis, stature, head-length, and head-breadth being considered.

TABLE XXVI.

Habitual Criminals in Scotland.

	Mean	Standard Deviation
Stature:		
Class No. I.	64·6 ± ·11	2·37 ± ·08 inches
,, ,, II.	65·0 ± ·18	2·68 ± ·13 ,,
,, ,, III.	65·3 ± ·20	2·28 ± ·14 ,,
,, ,, IV.	65·2 ± ·42	2·56 ± ·30 ,,
Totals	64·8 ± ·09	2·47 ± ·06 ,,
Head Length:		
Class No. I.	195·3 ± ·30	6·37 ± ·21 mm.
,, ,, II.	197·2 ± ·42	6·06 ± ·29 ,,
,, ,, III.	198·4 ± ·63	7·06 ± ·45 ,,
,, ,, IV.	195·3 ± ·70	4·02 ± ·47 ,,
Totals	196·3 ± ·23	6·44 ± ·16 ,,
Head Breadth:		
Class No. I.	152·9 ± ·22	4·70 ± ·16 mm.
,, ,, II.	153·9 ± ·29	4·24 ± ·20 ,,
,, ,, III.	153·5 ± ·43	4·83 ± ·31 ,,
,, ,, IV.	152·1 ± 1·06	6·50 ± ·71 ,,
Totals	153·5 ± ·16	4·57 ± ·11 ,,

Considering briefly in the first place the various classes of criminals themselves, it is seen that those habitual criminals who have been convicted of murder and assault, and in a lesser degree those convicted of theft, differ considerably in head-length from those convicted of robbery and assault and other crimes. They have on an average longer heads. The difference in head-length between Classes I and III is 4·43 times its probable error, and Class III differs in its mean head-length from the remaining population by about 3·8 times the probable error of the difference. The distinctive feature here is that those convicted of murder and assault have significantly longer heads than the other criminal population. The difference in head-breadth between Classes I and II, and in stature between Classes I and III are possibly significant, but in all other cases the differences in the various characters among the criminals are insignificant—they are fair random samples of the short series of the general criminal population of Scotland. A longer series of measurements might of course reveal significant differences which appear in this series to be insignificant.

On comparing now the Scottish "general insane" population with the Scottish habitual criminals, we find that they differ considerably in type. An inspection of the differences (relative to their probable errors) will show this at a glance.

TABLE XXVII.

Between	Relative Difference
Mean Head Lengths ...	3·40
„ Head Breadths ...	9·48
„ Statures ...	11·24

That is, the Scottish criminal's head is on an average longer and broader than that of the inmate of a Scottish asylum, but he is somewhat shorter in stature; or, conversely, the insane person is smaller headed but taller in stature than the criminal. This result may or may not be independent of the racial nature of either population. It is to be noted, however, that 35 per cent. of the criminals in Scottish asylums are of Irish origin. A very much smaller proportion of the "general insane" population are of Irish extraction.

III. *Scottish Crania.* Sir William Turner, in his valuable memoir on the "Craniology of the People of Scotland," finds the mean length and mean breadth of the crania examined by him to be respectively 186·8 mm. and 144·3 mm. Making an allowance of 8 mm. for scalp depth for each character and comparing these values with those of the "general insane" population, we see that the differences are quite insignificant. From measurements kindly made for the writer by Dr Theodore Shennon, Pathologist at the Edinburgh Royal Infirmary, the average depth of the scalp is found to be less than that given above. Altogether 110 subjects were measured, in the temporal region at both sides, and at the glabella and occipital point. Measurements on subjects still continue to be made, but until a much larger number have been measured it seems desirable to adhere to the figure usually given. In any case, the above result is a purely tentative one, and no stress is laid on it. Besides, as Sir William Turner points out, the crania are not quite representative of the whole of Scotland, and the series is a short one.

IV. *Local.* One only of the asylum groups can be compared with the normal population of practically the same area—that of Aberdeen. The writer's values for head length, head breadth, and stature of the Aberdeenshire population are 193·93 mm., 153·40 mm. and 67·7 inches respectively. The difference in head length is insignificant, but the sane population of Aberdeenshire is significantly broader headed and taller than the corresponding asylum population. Roxburgh Volunteers have been found by J. F. Macpherson* to have an average stature of 67·89 inches, and this is significantly greater than the corresponding asylum population. It must be remembered, however, that the Volunteers are a selected population, so that the only normal local observations directly comparable with the local insane are those of Aberdeen.

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* Stature of Roxburgh and Selkirk Volunteers: J. F. Macpherson.

V. *Stature.* Finally, stature generally falls to be briefly noticed. The following table shows the mean stature of the various Scottish populations measured by the writer, alongside those of other Anglo-Saxon populations whose values have been ascertained.

It will be observed that the first five classes in the table below are drawn from the normal or healthy populations, while the last five are either hospital patients, insane or criminals. So far as the Scottish populations are concerned it has been already pointed out that the sane are significantly taller than either criminals or the insane. It would thus appear that neither the criminals nor the insane are fair samples of the general population with respect to stature, these two classes being drawn more from the shorter section of the community.

TABLE XXVIII.

Stature—Males.—Anglo-Saxon or British Populations.

Class	Stature (inches)	Reference
Cambridge Students	68·86	*Biometrika*, Vol. I. p. 191, Macdonell
English Sons	68·86	Family data, Pearson
Roxburgh and Selkirk Volunteers	67·89	This Memoir
English Fathers	67·74	Family data, Pearson
Aberdeenshire Rural	67·72	This Memoir
General Hospital	67·16	*Biometrika*, Vol. IV. p. 126, Blakeman
Criminals, New South Wales ...	66·88	*Biometrika*, Vol. I. p. 44, Powys
Scottish Insane	65·86	This Memoir
English Criminals	65·54	*Biometrika*, Vol. I. p. 191, Macdonell
Scottish Criminals	64·84	This Memoir

(8) *General Conclusions.*

I. The fundamental problem (namely, does the insane population differ from the sane population?) cannot be answered from the data of this survey, at least with respect to measurable characters, since no corresponding complete survey of the sane population has been carried out. The mean stature of the Scottish insane, however, is significantly less than that of the sane population of any of the districts measured. With respect to the non-measurable characters, hair colour and eye colour, the colour data of the Scottish children being available, it has been found by direct and indirect comparison that the insane population does materially differ from the sane. On an average, the "general insane" population of Scotland is lighter-eyed and darker-haired than the sane population. There is a greater tendency to insanity among the light-eyed and dark-haired population than among any other colour class. Red-haired persons and dark-eyed persons seem less liable to insanity. With regard to the remaining colour characters there is no material difference between the sane and the insane.

II. In the one local district where the adult sane and insane populations can be compared—that of Aberdeen—it is found to agree, with respect to pigmentation, with the general conclusion just stated. With regard to measurable characters, the local sane population is broader headed and taller than the local insane.

III. In the entire insane population there is a group whose characters are affected by special causes not characteristic of insanity in general. This group has on that account been excluded from the general analysis. The group is quite different in type from the "general insane" population, is both macrocephalic and microcephalic in character, and thus shows excessive variability.

IV. (*a*) The distributions of the various characters in the general insane population are distinctly skew, with the possible exception of head length, which may be fairly described by the normal curve. Further, the distributions are leptokurtic and negatively asymmetric. For long series of the same characters, just as great divergences from normality occur among sane populations as are here found in the long general insane series. Asymmetry in distribution therefore is not a special feature among the insane. A difference in form, however, may exist between sane and insane populations. If it existed, it would be detected by a general survey of the sane population. In any case, heterogeneity would account for much of the asymmetry, and heterogeneity (see V. and VI.) has been found to exist among the insane.

(*b*) There is a probably significant departure from linearity of regression among the males in the pairs of characters L & B, B & H, and L & S. Otherwise the regression is linear. The values of the correlation coefficients are somewhat higher in the entire insane population. In the general insane population the values approximate to those already found for the same pairs of characters among the sane population.

V. Assuming the insane population in the various districts of Scotland to be, with respect to measurable characters, an anthropometric sample of each district, we find that local populations differ from each other sensibly in many respects.

(*a*) The south-west of Scotland (exclusive of Glasgow) is long-headed or macrocranial, the north-east is short-headed or brachycranial. The north of Scotland is broad-headed or platycranial. Glasgow, Edinburgh, and the populous centres round them are stenocranial or narrow-headed. Again, the north of Scotland is distinctly brachycephalic, while the south-west is distinctly dolichocephalic. In the large towns (excepting Edinburgh, which approximates to the mean) the population is microcephalic or small-headed. The Scottish Midlands, excluding towns, are macrocephalic or large-headed. The rest of the country approximates to the average size—the population is mesocephalic. In head height, there are two sharply divided groups—a hypsicranial or a high-headed group in the Midlands, and a chamaecranial or a low-headed one. The border counties are tall statured or megalomegithic. In the towns generally the population is significantly shorter—is micromegithic.

(*b*) The interlocal constants evaluated show that the population is not a homogeneous one, no matter what character be considered. Intralocally, it is seen that in some groups the means of most characters exceed their respective general means, and are therefore megalomeric in character; in others the means of most of the characters are significantly less than the corresponding general means and are therefore micromeric. In others the groups exceed the means in some and are in defect in others, and therefore possess a mixed specification—they are mictomeric groups.

VI. Few districts show greater variability than the general population. Inverness males and Aberdeen and Montrose females show greater variability in head height. Male inmates at Ayr show significantly low variability for all cranial characters. Fife males and females are a selected group with respect to stature.

VII. There is no significant difference between the two sexes in variability. The males, perhaps, appear more variable in head breadth, but otherwise males and females are very much alike in variability.

VIII. While it has been shown to be exceedingly probable that the general colour distributions of the insane differ significantly in some respects from those of the adult sane population (see I.), the colour distribution of the insane throughout Scotland is by no means uniform. Generally speaking the north of Scotland is a region of excess of dark and red hair and medium eyes; the south-west of medium hair; and the south, of light eyes. The country lying directly between the Firth of Forth and Firth of Clyde has an excess of fair hair as well as of dark eyes; and the Montrose group (which includes Caithness and Shetland as well as Kincardine and North Forfar) has also an excess of fair hair in the male population.

IX. Comparing the measurable characters of the Scottish insane population with the other available general Scottish data we find that (*a*) the insane are, on an average, probably shorter than the sane; (*b*) there is a distinct difference in type between the class or race material from which the insane and the criminals are drawn, the criminals being larger-headed and shorter men on an average than the insane. If the criminals and the insane belonged to the same race, or contained proportionally the same racial elements, it would be clear that the criminals were drawn from a physically different section of the community. About 35 per cent. of the habitual criminals in Scotland, however, are of Irish extraction, and the problem, thus complicated, cannot be solved without a knowledge of the physical characters of both races. Incidentally, the criminals differ little among themselves. They are a homogeneous group, excepting that the class convicted of murder and assault have significantly longer heads than the others; (*c*) so far as can be judged, comparing head and skull measurements, there is little difference between the asylum population and Turner's Scottish cranial series.

Synopsis of Terms.

Specific Terms.

Character	Relation of the mean to the general mean to which it is compared		Reference
	Greater	Less	
L	macrocranial	brachycranial	*Biometrika*, Vol. I. Fawcett's Memoir
B	platycranial	stenocranial	” ” ”
H	hypsicranial	chamaecranial	” ” ”
B/*L*	brachycephalic	dolichocephalic	” ” ”
H/*L*	hypsicephalic	chamaecephalic	” ” ”
B/*H*	platycephalic	stenocephalic	” ” ”
S	megalomegithic (or macromegithic)	micromegithic (or brachymegithic)	This memoir
LBH	macrocephalic	microcephalic	”

General Terms.

Character or group	The value of the constant found, compared with the corresponding constant of the general population is (considering the sample as a random one)			Reference
	Significantly Greater	Insignificantly Different	Significantly Less	
Any character ...	megalometropic (or macrometropic)	isometropic	micrometropic	This memoir
Any group, for all or most characters	megalomeric (or macromeric)	isomeric	micromeric	”
A mictomeric group is one where the characters are partly megalo- and partly micrometropic, with or without being also isometropic.				”

ON THE ERROR OF COUNTING WITH A HAEMACYTOMETER.

By Student.

When counting yeast cells or blood corpuscles with a hæmacytometer there are two main sources of error: (1) the drop taken may not be representative of the bulk of the liquid; (2) the distribution of the cells or corpuscles over the area which is examined is never absolutely uniform, so that there is an "error of random sampling."

With the first source of error we are concerned only to this extent; that when the probable error of random sampling is known we can tell whether the various drops taken show significant differences. What follows is concerned with the distribution of particles throughout a liquid, as shewn by spreading it in a thin layer over a measured surface and counting the particles per unit area.

Theoretical Consideration.

Suppose the *whole* liquid to have been well mixed and spread out in a thin layer over N units of area (in the hæmacytometer the usual thickness is ·01 mm. and the unit of area $\frac{1}{400}$ sq. mm.).

Let the particles subside and let there be on an average m particles per unit area, that is Nm altogether. Then assuming the liquid has been properly mixed a given particle will have an equal chance of falling on any unit area.
i.e. the chance of its falling in a given unit area is $1/N$ and of its not doing so $1-1/N$.

Consequently considering all the mN particles the chances of 0, 1, 2, 3 ... particles falling on a given area are given by the terms of the binomial $\left\{\left(1-\frac{1}{N}\right)+\frac{1}{N}\right\}^{mN}$, and if M unit areas be considered the distribution of unit areas containing 0, 1, 2, 3 ... particles is given by $M\left\{\left(1-\frac{1}{N}\right)+\frac{1}{N}\right\}^{mN}$.

Now in practice N is to be measured in millions and may be taken as infinite.

Let us find the limit when N is infinite of the general term of this expansion. The $(r+1)$th term is:

$$\left(1-\frac{1}{N}\right)^{mN-r}\cdot\left(\frac{1}{N}\right)^r\frac{mN(mN-1)(mN-2)\ldots(mN-r+1)}{r\,!}$$

$$=\left(1-\frac{1}{N}\right)^{mN-r}\frac{m\left(m-\frac{1}{N}\right)\left(m-\frac{2}{N}\right)\ldots\left(m-\frac{r-1}{N}\right)}{r\,!}$$

$$=\left(1-\frac{mN-r}{N}+\frac{(mN-r)(mN-r-1)}{N^2\,.\,2\,!}-\ldots\right.$$
$$\left.+(-1)^s\frac{(mN-r)\ldots(mN-r-s+1)}{N^s\,.\,s\,!}+\ldots\right)$$
$$\times\, m\frac{\left(m-\frac{1}{N}\right)\left(m-\frac{2}{N}\right)\ldots\left(m-\frac{r-1}{N}\right)}{r\,!}.$$

But when we proceed to the limit $\frac{1}{N}, \frac{2}{N}\ldots\frac{r-1}{N}$ and $\frac{r}{N}, \frac{r+1}{N}\ldots\frac{r+s-1}{N}$ are all negligeably small compared to m so that the expression reduces to

$$\left(1-m+\frac{m^2}{2\,!}-\ldots+(-1)^s\frac{m^s}{s\,!}\ldots\right)\times\frac{m^r}{r\,!}=e^{-m}\times\frac{m^r}{r\,!}.$$

That is to say that the expansion is equal to

$$e^{-m}\left\{1+m+\frac{m^2}{2\,!}+\ldots+\frac{m^r}{r\,!}+\ldots\right\}.$$

Hence it is this distribution with which we are concerned.

The 1st moment about the origin, O, taken at zero number of particles is

$$e^{-m}\left\{m+\frac{2m^2}{2\,!}+\frac{3m^3}{3\,!}+\ldots+\frac{rm^r}{r\,!}+\ldots\right\}$$

$$=me^{-m}\left\{1+\frac{m}{1!}+\frac{m^2}{2\,!}+\ldots+\frac{m^{r-1}}{(r-1)\,!}+\ldots\right\}$$

$$=m\times\text{total frequency}.$$

Hence the mean is at m.

The 2nd moment about the point O is

$$e^{-m}\left\{m+\frac{2^2m^2}{2\,!}+\frac{3^2m^3}{3\,!}+\ldots+\frac{r^2m^r}{r\,!}+\ldots\right\}$$

$$=e^{-m}\left\{m+\frac{2m^2}{1\,!}+\frac{3m^3}{2\,!}+\ldots+\frac{rm^r}{(r-1)!}+\ldots\right\}$$

$$=e^{-m}\left\{m+\frac{m^2}{1\,!}+\ldots+\frac{m^r}{(r-1)!}+\ldots+m^2+\frac{2m^3}{2\,!}+\ldots+\frac{(r-1)\,m^r}{(r-1)\,!}+\ldots\right\}$$

$$=(m+m^2)\times\text{total frequency}.$$

Hence the second moment-coefficient about the mean

$$\mu_2 = m + m^2 - m^2 = m.$$

By similar* methods the moment-coefficients up to μ_6 were obtained, as follows:

$$\mu_1' = m.$$
$$\mu_2 = m.$$
$$\mu_3 = m.$$
$$\mu_4 = 3m^2 + m.$$
$$\mu_5 = 10m^2 + m.$$
$$\mu_6 = 15m^3 + 25m^2 + m.$$

Hence $$\beta_1 = \frac{\mu_3^2}{\mu_2^3} = \frac{1}{m},$$

and $$\beta_2 = \frac{\mu_4}{\mu_2^2} = 3 + \frac{1}{m}.$$

It will be observed that the limit to which this distribution approaches as m becomes infinite is the normal curve with its β_1, β_3, β_5, etc., all equal to 0, and $\beta_2 = 3$, $\beta_4 = 15$, etc.

Further, any binomial $(p+q)^n$ can be put into the form $(p+q)^{nq/q}$, and if q be small and nq not large it approaches the distribution just given.

Thus if $1000\left(\frac{99}{100} + \frac{1}{100}\right)^{500}$ be expanded the greatest difference between any of its terms and the corresponding term of $1000\, e^{-5}\left(1 + 5 + \frac{5^2}{2\,!} + \ldots + \frac{5^r}{r\,!} + \ldots\right)$

---

* The evaluation of the moments about the point O will be found to depend on the expansion of r^n in the form

$$r^n = r\left\{\frac{(r-1)\,!}{(r-n-2)\,!} + a_1\frac{(r-1)\,!}{(r-n-1)\,!} + a_2\frac{(r-1)\,!}{(r-n)\,!} + \ldots + a_{n+1}\frac{(r-1)\,!}{(r-1)\,!}\right\}$$
$$= r\left\{\frac{1}{(r-n-2)\,!} + \frac{a_1}{(r-n-1)\,!} + \frac{a_2}{(r-n)\,!} + \ldots + \frac{a_{n+1}}{(r-1)\,!}\right\}(r-1)\,!$$

Then if we form the series for $n+1$ from this it will be found that the following relations hold between a_1, a_2, a_3 etc. and the corresponding coefficients for $n+1$, A_1, A_2, A_3 etc.

$$A_1 = a_1 + n,$$
$$A_2 = a_2 + (n-1)\,a_1,$$
$$A_p = a_p + (n-p+1)\,a_{p-1}.$$

From these equations we can write down any number of moments about the point O in turn, and from these may be found the moments about the mean by the ordinary formulae.

The moments may also be deduced from the point binomial $(p+q)^{nq/q}$ when q is small and n large and $nq=m$, i.e. $p=1$, $q=0$, $nq=m$. We have

$$\mu_1' = nq = m,$$
$$\mu_2 = npq = m,$$
$$\mu_3 = npq\,(p-q) = m,$$
$$\mu_4 = npq\,\{1 + 3\,(n-2)\,pq\} = m\,(1+3m) = 3m^2 + m.$$

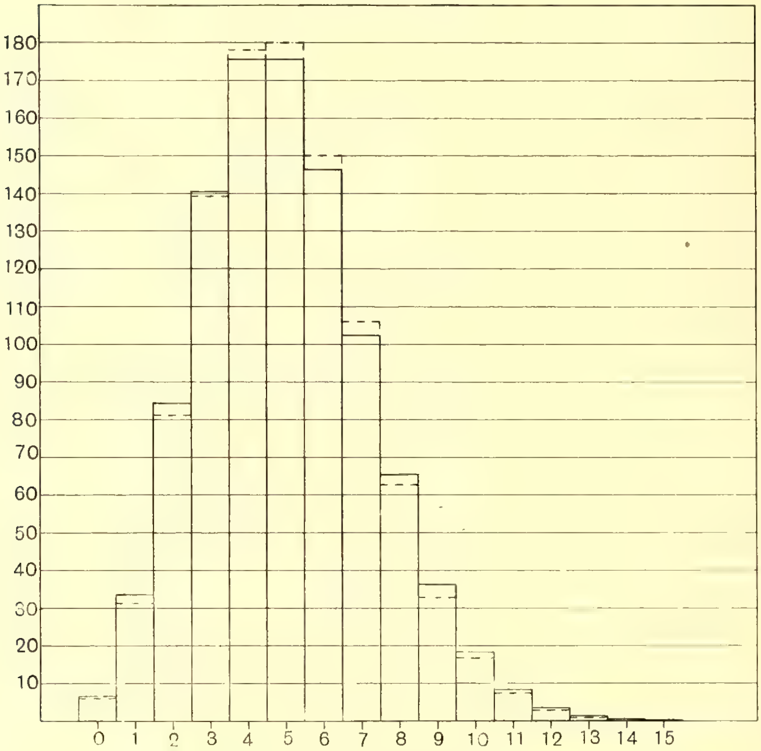
is never as much as 1, being about ·8 for the term $1000\, e^{-5} \frac{5^5}{5\,!}$ which is 175·5 against 176·3 from the binomial.

Diagram I compares $1000\, e^{-5} \left(1 + 5 + \frac{5^2}{2\,!} + \ldots + \frac{5^r}{r\,!} + \ldots\right)$ with the binomial $1000\, (\frac{19}{20} + \frac{1}{20})^{100}$ which of course differ, but not by very much.

DIAGRAM I. Comparison of the exponential and binomial expansions.

Firm line represents $1000\, e^{-5} \left\{1 + 5 + \ldots + \frac{5^r}{r\,!} + \text{etc.}\right\}$.

Broken line represents $1000 \left\{\frac{19}{20} + \frac{1}{20}\right\}^{100}$.



In applying this to actual cases it must be noted that we have not taken into account any "interference" between the particles; there has been supposed the same chance of a particle falling on an area which already has several particles as on one altogether unoccupied. Clearly if m be large this will not be the case, but with the dilutions usually employed this is not of any importance.

It will be shewn that the actual distributions which were tested do not diverge widely from this law, so we will consider the probable error of random sampling on the supposition that they follow it.

We have seen that $\mu_2 = m$.

Hence the standard deviation $= \sqrt{m}$.

So that if we have counted M unit areas the probable error of our mean (m) is $\cdot 67449 \sqrt{\frac{m}{M}}$.

If we are working with a hæmacytometer in which the volume over each square is $\frac{1}{40000}$ mm. there will be 40,000,000 m particles per c.c. and the probable error will be $40{,}000{,}000 \times \cdot 67449 \times \sqrt{\frac{m}{M}}$.

Suppose now that we dilute the liquid to q times its bulk, we shall then have $\frac{m}{q}$ particles per square, and if we count M squares as before, our probable error for the number of particles per c.c. in the original solution will be $40{,}000{,}000 \times \cdot 67449 \times q \sqrt{\frac{m}{q} \times \frac{1}{M}}$. That is $40{,}000{,}000 \times \cdot 67449 \sqrt{\frac{mq}{M}}$.

That is we shall have to count qM squares in order to be as accurate as before.

So that the same accuracy is obtained by counting the same number of particles whatever the dilution, or, to look at it from a slightly different point of view, whatever be the size of the unit of area adopted.

Hence the most accurate way is to dilute the solution to the point at which the particles may be counted most rapidly, and to count as many as time permits: then the probable error of the mean is $\cdot 67449 \sqrt{\frac{m}{M}}$ where m is the mean and M is the number of unit areas counted over, squares, columns of squares, microscope fields, or whatever unit be selected.

But owing to the difficulty of obtaining a drop representative of the bulk of the liquid the larger errors will probably be due to this cause, and it is usual to take several drops: if two of these differ in their means by a significant amount compared with the probable error (which is $\cdot 67449 \sqrt{\frac{m_1 + m_2}{M}}$ where m_1, m_2 are the means and M the number of unit areas counted), it is probable that one at least of the drops does not represent the bulk of the solution.

Experimental Work.

This theoretical work was tested on four distributions * which had been counted over the whole 400 squares of the hæmacytometer. The particles counted were yeast cells which were killed by adding a little mercuric chloride to the water in which they had been shaken up. A small quantity of this was mixed with a 10 °/₀ solution of gelatine, and after being well stirred up drops were put on the hæmacytometer. This was then put on a plate of glass kept at a temperature just above the setting point of gelatine and allowed to cool slowly till the gelatine had set. Four different concentrations were used.

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* One of these is given in Table I.

In this way it was possible to count at leisure without fear of the cells straying from one square to another owing to accidental vibrations. A few cells stuck here and there to the cover glass, but as they appeared to be fairly uniformly distributed and were very few compared with those that sank to the bottom they were neglected: had the object of the experiment been to find the number of cells present they would have been counted by microscope fields, and correction made for them; but in our case they were considered to belong to a different "population" to those which sank.

Those cells which touched the bottom and right-hand lines of a square were considered to belong to the square; a convention of this kind is necessary as the cells have a tendency to settle on the lines.

There was some difficulty owing to the buds of some cells remaining undetached in spite of much shaking. In such cases an obvious bud was not counted, but sometimes, no doubt, a bud was counted as a separate cell, which slightly increases the number of squares with large numbers in them.

In order to test whether there was any local lack of homogeneity the correlation was determined between the number of cells on a square and the number of cells on each of the four squares nearest it; if from any cause there had been a tendency to lie closer together in some parts than in others this correlation would have been significantly positive.

Distributions 3 and 4 were tested in this way (Table II), with the result that the correlation coefficients were + ·016 ± ·037 and ·015 ± ·037. This is satisfactory as shewing that there is no very great difficulty in putting the drop on to the slide so as to be able to count at any point and in any order; as good a result may be expected from counting a column as from counting the same number of squares at random.

The actual distributions of cells are given below, and compared with those calculated on the supposition that they are random samples from a population following the law which we have investigated: the probability P of a worse fit occurring by chance is then found.

I. Mean $=·6825$: $\mu_2=·8117$: $\mu_3=1·0876$.

Containing	0	1	2	3	4	5 cells
Actual	213	128	37	18	3	1
Calculated	202	138	47	11	1·84	·24
					2	

Whence $\chi^2=9·92$ and $P=·04$.

Best fitting binomial $(1·1893-·1893)^{-3·6054}\times 400$ for which $P=·52$.

II. Mean $=1·3225$: $\mu_2=1·2835$ μ_3 : $=1·3574$.

	0	1	2	3	4	5	6
Actual	103	143	98	42	8	4	2
Calculated	106	141	93	41	14	4	1

Whence $\chi^2=3·98$ and $P=·68$.

Best fitting binomial $(·97051+·02949)^{46·2084}\times 400$ for which $P=·72$.

III. Mean $=1{\cdot}80$: $\mu_2=1{\cdot}96$: $\mu_3=2{\cdot}529$.

	0	1	2	3	4	5	6	7	8	9
Actual	75	103	121	54	30	13	2	1	0	1
Calculated	66	119	107	64	29	10	3	1		

Whence $\chi^2=9{\cdot}03$ and $P={\cdot}25$.

Best fitting binomial $(1{\cdot}0889-{\cdot}0889)^{-20{\cdot}2473}\times 400$ for which $P={\cdot}37$.

IV. Mean $=4{\cdot}68$: $\mu_2=4{\cdot}46$: $\mu_3=4{\cdot}98$.

	0	1	2	3	4	5	6	7	8	9	10	11	12
Actual	0	20	43	53	86	70	54	37	18	10	5	2	2
Calculated	4	17	41	63	74	70	54	36	21	11	5	2	1

Whence $\chi^2=9{\cdot}72$ and $P={\cdot}64$.

Best fitting binomial $({\cdot}9525+{\cdot}0475)^{98{\cdot}53}\times 400$ for which $P={\cdot}68$.

These results are given graphically in Diagram II. on the next page.

It is possible to fit a point binomial from the mean and the 2nd moment according to the two equations $\mu_1'=nq$, $\mu_2=npq$ and these point binomials fit the observations better than the exponential series, but the constants have no physical meaning except that $nq=m$. And since the exponential series is a particular form of the point binomial and is fitted from one constant, while two are used for the "ad hoc" binomial, this better fit was only to be expected.

It will be noticed that in both I and III the 2nd moment is greater than the mean, due to an excess over the calculated among the high numbers in the tail of the distribution. As was pointed out before, the budding of the yeast cell increases these high numbers, and there is also probably a tendency to stick together in groups which was not altogether abolished even by vigorous shaking.

In any case, the probabilities ·04, ·68, ·25 and ·64, though not particularly high, are not at all unlikely in four trials, supposing our theoretical law to hold, and we are not likely to be very far wrong in assuming it to do so.

Let us now apply it to a practical problem: for some purposes it is customary to estimate the concentration of cells and then dilute so that each two drops of the liquid contain on an average one cell. Different flasks are then seeded with one drop of the liquid in each, and then "most of those flasks which show growths are pure cultures."

The exact distribution is given by

$$e^{-\frac{1}{2}}\left(1+\frac{1}{2}+\frac{(\frac{1}{2})^2}{2\,!}+\frac{(\frac{1}{2})^3}{3\,!}+\dots\right),$$

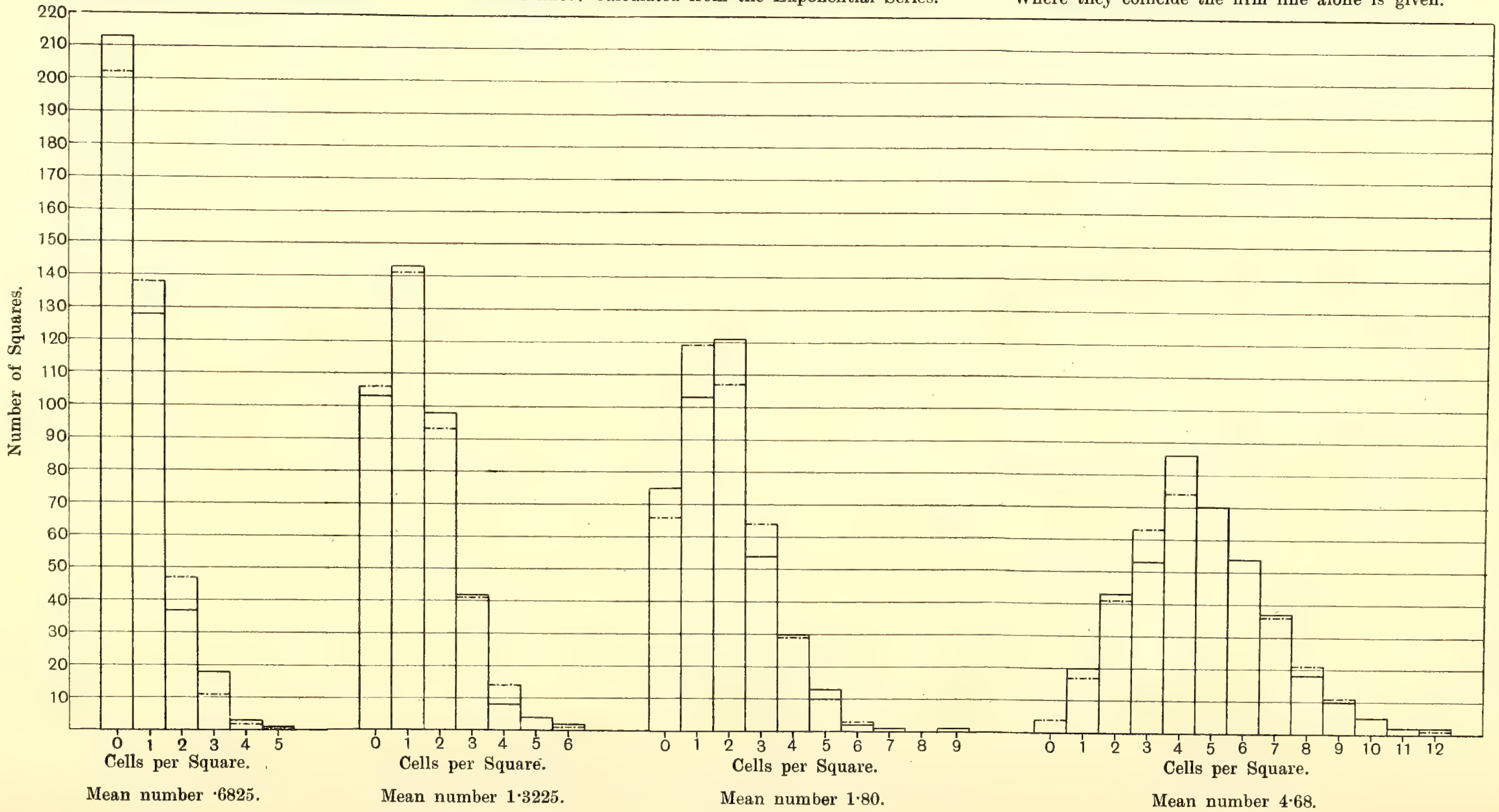
which is

No. of Yeast cells	*0*	*1*	*2*	*3*	*4*
Percentage Frequency	60·65	30·33	7·58	1·26	·16

or approximately three-quarters of those which show growth are pure cultures.

DIAGRAM II. Distribution of 400 Squares.

Firm lines: Actual Observations. Broken lines: Calculated from the Exponential Series. Where they coincide the firm line alone is given.



Conclusions.

We have seen that the distribution of small particles in a liquid follows the law

$$e^{-m}\left\{1+m+\frac{m^2}{2\,!}+\ldots+\frac{m^r}{r\,!}+\ldots\right\}$$

where m is the mean number of particles per unit volume* and the various terms in the series give the chances that a given unit volume contains 0, 1, 2, ... r, ... particles. We have also seen that this series represents the limit to which any point binomial $(p+q)^n$ approaches when q is small, insomuch that even $(\frac{19}{20}+\frac{1}{20})^{100}\times 1000$ is represented by $e^{-5}\left(1+5+\frac{5^2}{2\,!}+\ldots+\frac{5^r}{r\,!}+\ldots\right)\times 1000$ with a maximum error of about 4·5 in 180.

For the rough calculation of odds with n small compared to $\frac{1}{q}$ the exponential series may be used instead of the binomial as being less laborious.

Finally, we have found that the standard deviation of the mean number of particles per unit volume is $\sqrt{\frac{m}{M}}$ where m is the mean number and M the number of unit volumes counted, so that the criterion of whether two solutions contain different numbers of cells is whether m_1-m_2 is significant compared with $\cdot67449\sqrt{\frac{m_1}{M_1}+\frac{m_2}{M_2}}$.

TABLE I.

Distribution of Yeast Cells over 1 *sq. mm. divided into* 400 *squares.*

2	2	4	4	4	5	2	4	7	7	4	7	5	2	8	6	7	4	3	4
3	3	2	4	2	5	4	2	8	6	3	6	6	10	8	3	5	6	4	4
7	9	5	2	7	4	4	2	4	4	4	3	5	6	5	4	1	4	2	6
4	1	4	7	3	2	3	5	8	2	9	5	3	9	5	5	2	4	3	4
4	1	5	9	3	4	4	6	6	5	4	6	5	5	4	3	5	9	6	4
4	4	5	10	4	4	3	8	3	2	1	4	1	5	6	4	2	3	3	3
3	7	4	5	1	8	5	7	9	5	8	9	5	6	6	4	3	7	4	4
7	5	6	3	6	7	4	5	8	6	3	3	4	3	7	4	4	4	5	3
8	10	6	3	3	6	5	2	5	3	11	3	7	4	7	3	5	5	3	4
1	3	7	2	5	5	5	3	3	4	6	5	6	1	6	4	4	4	6	4
4	2	5	4	8	6	3	4	6	5	2	6	6	1	2	2	2	5	2	2
5	9	3	5	6	4	6	5	7	1	3	6	5	4	2	8	9	5	4	3
2	2	11	4	6	6	4	6	2	5	3	5	7	2	6	5	5	1	2	7
5	12	5	8	2	4	2	1	6	4	5	1	2	9	1	3	4	7	3	6
5	6	5	4	4	5	2	7	6	2	7	3	5	4	4	5	4	7	5	4
8	4	6	6	5	3	3	5	7	4	5	5	5	6	10	2	3	8	3	5
6	6	4	2	6	6	7	5	4	5	8	6	7	6	4	2	6	1	1	4
7	2	5	7	4	6	4	5	1	5	10	8	7	5	4	6	4	4	7	5
4	3	1	6	2	5	3	3	3	7	4	3	7	8	4	7	3	1	4	4
7	6	7	2	4	5	1	3	12	4	2	2	8	7	6	7	6	3	5	4

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* The prism standing on unit area.

It must be noted, however, that the probable error will always be greater than that calculated on this formula when for any reason the organisms occur as aggregates of varying size.

In conclusion, I should like to thank Prof. Adrian J. Brown, of Birmingham University, for his valuable advice and assistance in carrying out the experimental part of the enquiry.

TABLE II.

"Centre" Squares.

"Adjacent" Squares	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	Totals
1	6	6	9	15	15	9	4	3	2	—	—	—	69
2	6	14	17	31	24	17	10	5	6	2	1	1	134
3	8	15	25	32	37	20	15	7	7	1	4	—	171
4	18	34	33	45	48	41	22	7	5	4	1	—	258
5	15	24	37	47	39	37	18	12	11	4	1	2	247
6	9	17	25	39	34	32	14	8	2	4	1	1	186
7	5	12	14	21	19	16	9	7	3	—	—	—	106
8	3	5	7	8	12	8	6	1	3	4	—	—	57
9	2	6	7	5	10	2	2	3	—	1	—	—	38
10	—	1	1	4	4	4	—	3	—	1	—	—	18
11	—	1	4	1	1	1	—	—	—	—	—	—	8
12	—	1	1	—	1	1	—	—	—	—	—	—	4
Totals	72	136	180	248	244	188	100	56	40	20	8	4	1296

Mean of "Centre" Squares, 4·6821 ; S. D., 2·139.

Mean of "Adjacent" Squares, 4·7014 ; S. D., 2·116.

$r = + \cdot 016 \pm \cdot 037$.

Correlation table between the number of cells in a square and the numbers of cells in the four adjacent squares taken all over Table I.

MISCELLANEA.

On the Distribution of Severity of Attack in Cases of Smallpox.

By F. M. TURNER, M.D.

On Vol. IV. pp. 505–510 of *Biometrika*, Prof. Pearson gives reasons for believing that the distribution of severity among cases of smallpox is either normal, or not sufficiently skew to sensibly affect the calculations of correlation tables by normal curve formulae. His arguments are partly *a priori*; of direct evidence he only produces a list of cases of smallpox classified according to the length of time the patients were considered too ill to be bathed.

The following evidence to the contrary seems to me very strong. For over 10 years Dr Ricketts, formerly the Superintendent of the Hospital Ships, now Superintendent of all the smallpox hospitals of the Metropolitan Asylums Board, has divided his cases into six classes defined as follows:

Class	I.	Haemorrhagic cases.
„	II.	Cases confluent in the vesicular stage.
„	III.	Cases confluent, but not before the pustular stage.
„	IV.	Cases intermediate between classes III and V.
„	V.	Cases with from 100 to 500 pocks upon the face.
„	VI.	Cases with less than 100 pocks on the face.

It will be seen that all the classes except I are defined by the severity of the eruption. In Class I the cases are so severe as to die, almost without exception, either before any eruption appears or before it is fully developed. It is almost certain that the cases of this class would belong to either Class II or III, if they lived long enough.

When I was working under Dr Ricketts two years ago, he generously put his records at my disposal, and I found that in the year 1902 the following number of patients were treated at Long Reach Hospital and the Hospital Ships:

Class	I.	266	Class	IV.	1141
„	II.	291	„	V.	1385
„	III.	1015	„	VI.	2851
				Total	6949.

To get the comparative frequency of different degrees of severity of eruption we require a quantitative definition of the classes, which is given in Classes V and VI and may be ascertained with some approach to accuracy, as I shall shew below, in Classes II, III, and IV. That severity of disease in smallpox is very closely connected with severity of eruption is quite evident to me; and will, I believe, be admitted to be so by all who have had practical acquaintance of the disease.

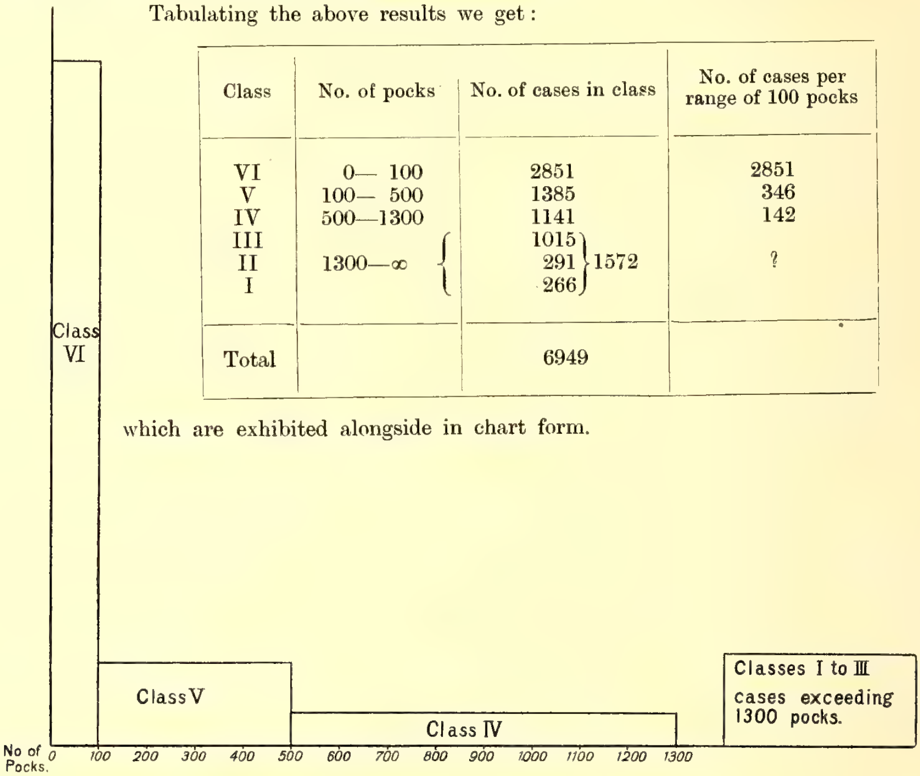
To determine the superior limit of Class IV Dr Ricketts has sent me a photograph taken by his assistant, Dr Byles, which has been used as a standard, dividing Classes III and IV. The photograph is endorsed "Class III. Cases of less numerical severity fall into Class IV." The photograph is a profile view and on the half face I have counted 672 pocks. This number must not be taken as absolutely correct, partly because it is difficult to distinguish the individual pocks which have run together to form a group, partly because pocks are found of all sizes; besides those fully formed are others of small size, and others abortive, and it is difficult to draw a definite line in counting. Still the evidence shows that the division between Classes III and IV corresponds to about 1300 pocks.

For the number of pocks corresponding to Classes II and III I have only very rough evidence. In two large scale photographs of cases in these two classes I estimated the number of pocks at about 5000 and 2000 respectively. The pocks were so densely crowded that it was impossible to count them accurately. All I could do was to count those in one square inch of each photograph and multiply by the approximate area of the photograph. These photographs were of individual cases only and were not used as divisions between classes, nor as types. Consequently I have not used these figures in the table.

Tabulating the above results we get:

Class	No. of pocks	No. of cases in class	No. of cases per range of 100 pocks
VI	0—100	2851	2851
V	100—500	1385	346
IV	500—1300	1141	142
III	1300—∞	1015	
II		291 } 1572	?
I		266	
Total		6949	

which are exhibited alongside in chart form.



The skewness of the diagram is of a high order.

Further Remarks on the Distribution of Severity in Cases of Smallpox.

By KARL PEARSON, F.R.S.

In his paper in *Biometrika*, Vol. IV. pp. 483–504, Dr Turner obtained a series of values for the relation between severity of disease and vaccination, and in a discussion on these suggested that a normal distribution ought rather to be assumed for the whole population exposed to risk of infection than for the population actually attacked by the disease. He suggested that the attacked population is really a "curtailed" normal distribution and considered formulae for such "curtailed" distributions.

In a note on Dr Turner's memoir I took the only test of smallpox severity which was at my disposal, namely the distribution of intervals which the physicians at Glasgow allow to elapse between (i) onset and (ii) eruption and the first bath; this I have been assured is a rough but fair measure of the severity of the attack. I showed that in these cases the maximum severity did not occur with the mildest attacks, or the distribution was not "curtailed" in the manner suggested by Dr Turner. Further, I indicated that curtailed distributions did not arise in such cases as Dr Turner anticipated, *e.g.* the stature distribution of selected soldiers. In fact most of our anthropometric distributions have been more or less selected, artificially or naturally, and they appear as a rule to be as normal as unselected material.

Dr Turner has replied to my criticism with some interesting further statistics of smallpox. He takes the number of pock marks as given by the scheme below:

Marks	0–100	100–500	500–1300	over 1300
Frequency	2851	1385	1141	1572

and suggests that they show a maximum frequency with the mildest cases. He does not, however, consider how far they approximate to that curtailed normal population, which as a whole he supposes to represent the total population which has run the risk of infection. Taking the four groups as they stand, the part of no normal curve whatever will even approximately fit them. It may be argued that the failure arises from a considerable number of the mildest cases, escaping notice at all. My assistant, Mr E. B. Ross, has therefore taken up the problem, omitting the first group altogether. Taking total population to rise by multiples of 10, he shows that the only way even to approach Dr Turner's numbers is enormously to increase the total population of which the above is to represent the tail, but millions and billions of population running the risk of infection will not suffice. In fact the ratio of the bases of the two groupings $\frac{1300-500}{500-100}$ is 2, and the limit to this ratio for the given frequencies treated as normal even if the risk-running population were infinite would only be 1·32. As a matter of fact the "spot maps" show how small was the population which ran the risk of infection even in the London epidemic of 1901–2. Thus whether we include or exclude the group 0 to 100, Dr Turner's data are wholly impossible even as an approximation to a curtailed normal curve. This want of any approach to normality suggests the question of whether the material is even approximately homogeneous. Is it possible that the number of pock marks may be different according to the extent of acquired immunity? Is it not also true that 5 or 10 pocks are almost as rare as haemorrhagic cases and the frequency increases from such values up to at least 100 pocks? In other words the modal severity is not as Dr Turner's diagram would lead one to suppose at the very mildest cases. If this be so, then the problem hinges on whether it is right to suppose severity a *linear* function of the number of pocks. Non-linear functions would not affect the application of fourfold-table methods, but they would affect the legitimacy of Dr Turner's argument.

I think it will be found that unvaccinated cases *at least* follow fairly closely a normal distribution of pocking. Dr J. Brownlee kindly provides me with all the material available from the Glasgow Epidemic, 1900–1. We have:

	Sparse	Abundant	Confluent	Haemorrhagic	Totals
Cases	9	41	61	4	115
Deaths	1	12	42	4	59
Percentage Deaths ± P.E.	11·1 ± 7·2	29·3 ± 4·8	68·9 ± 4·4	100 ± 9·8* ?	51·3

Assuming the distribution normal I find:

Range of "Sparse" : from $-\infty$ to $-1{\cdot}417\sigma$; mean of group $-1{\cdot}868\sigma$,
„ „ "Abundant" : „ $-1{\cdot}417\sigma$ to $-0{\cdot}164\sigma$; „ „ $-{\cdot}694\sigma$,
„ „ "Confluent" : „ $-0{\cdot}164\sigma$ to $+1{\cdot}815\sigma$; „ „ $+{\cdot}597\sigma$,
„ „ "Haemorrhagic": „ $+1{\cdot}815\sigma$ to $+\infty$; „ „ $+2{\cdot}208\sigma$.

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* Deduced by an extension of Bayes' Theorem.

Fitting lineally by Least Squares (weighted with the number of observations) the means of the groups to the corresponding death-rates, we have if x be the abscissa of normal curve

$$\text{Death-rate} = 51\cdot3 + 25\cdot7x/\sigma.$$

This gives :

Death-rate	Sparse	Abundant	Confluent	Haemorrhagic
Range	0 to 15·0	15·0 – 47·2	47·2 – 97·9	97·9 upwards
Value at Mean of Class	3·4	33·5	66·7	108·0*
Observed Value ...	11·1 ± 7·2	29·3 ± 4·8	68·9 ± 4·4	100 ± 9·8?

These results are well within the errors of the samples given. The death-rate at the mean amount of pocking is 51·3. Thus, if we assume the amount of severity as given by pocking to follow a normal curve, the scale of severity obtained fits well the severity of the classes as found by a death-rate standard. It is further clear that the modal value lies in the confluent class and does not coincide with the slightest cases. Further there is a very high correlation between severity as measured by a normal scale of pock-marking, and severity as measured by death-rate in the case of *no acquired* immunity.

If an investigation similar to the present on cases vaccinated,—say within ten years—should show that a normal distribution of pock-markings fits in well there also with the death-rate severity scale, it would indicate that Dr Turner's severity skewness is due to a mixture of vaccinated and unvaccinated in his returns. Dr Brownlee's view that the disease is physiologically different in the two classes would thus be confirmed. The discussion having turned on the distribution of severity in disease, has got somewhat far from the original point, as to whether the case population, recovering and dying, could be represented by a normal curve. But clearly death on such a scale marks a certain intensity of the disease relative to the individual constitution ; a scale of pock-marking cannot, we see from the above statistics, be equivalent to this scale ; for deaths occur with all classes of pocking, and death cannot accordingly be made to correspond to a definite intensity of severity on a pocking scale. In short "power to resist disease when acquired" might obey a normal distribution although pocking did not, for failure to recover is not a fixed point on the scale of number of pocks.

If we have to dismiss entirely Dr Turner's suggestion of a curtailed normal curve, I cannot dismiss his severity statistics in the easy way in which he appears to dismiss mine. The bath test appears to me quite as valid as the pock test. It is further in accordance with a very considerable range of statistics for various diseases which have recently been published by Dr John Brownlee[†], and which all go to show that the severity in other diseases is not such that the maximum frequency occurs at the minimum severity, but that the mean severity is approximately modal with milder and severer cases on either side.

It will thus be seen that the matter really demands further statistics. Is smallpox an exceptional disease for which the absolutely mildest cases are the most frequent? Or, may it not be that there is some method of reconciling the pock test of severity with the bath test of severity for which smallpox falls into line with other diseases ? It appears to me that there are many other factors highly correlated with time and contributing to severity which may be largely overlooked by the numerical estimate of pocking as the sole test of severity and take their proper place and influence in the bath test, or what for our present purposes is more important than either, in a "power of resistance" test.

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[*] This is no impossible value, for the severity might be more than sufficient to kill the whole number of haemorrhagic cases.

[†] *Royal Phil. Soc. Glasgow Proceedings*, November 7, 1906.

Supplement to Vol. V. of Biometrika.

ANTHROPOMETRIC SURVEY

OF THE

INMATES OF ASYLUMS IN SCOTLAND

BY

J. F. TOCHER.

APPENDIX I.—RECORD OF MEASUREMENTS AT THE VARIOUS ASYLUMS, PP. 5-80.

APPENDIX II.—TABLES OF CLASSIFIED DATA, PP. 81-ET SEQ.

[*To accompany the memoir on " The Anthropometric Characteristics of the Inmates of Asylums in Scotland," by J. F. Tocher.*]

1906.

Through the kindness of the Henderson Trust of Edinburgh, permission has been given to reprint the original data bearing on the Survey of the Inmates of Asylums in Scotland. The Editors beg to acknowledge their indebtedness to the Members of the Trust, and to thank them for their kindness in granting permission to reprint from their first Report such useful material.

Explanatory Note to Tables.

APPENDIX I.—*Measurements.*

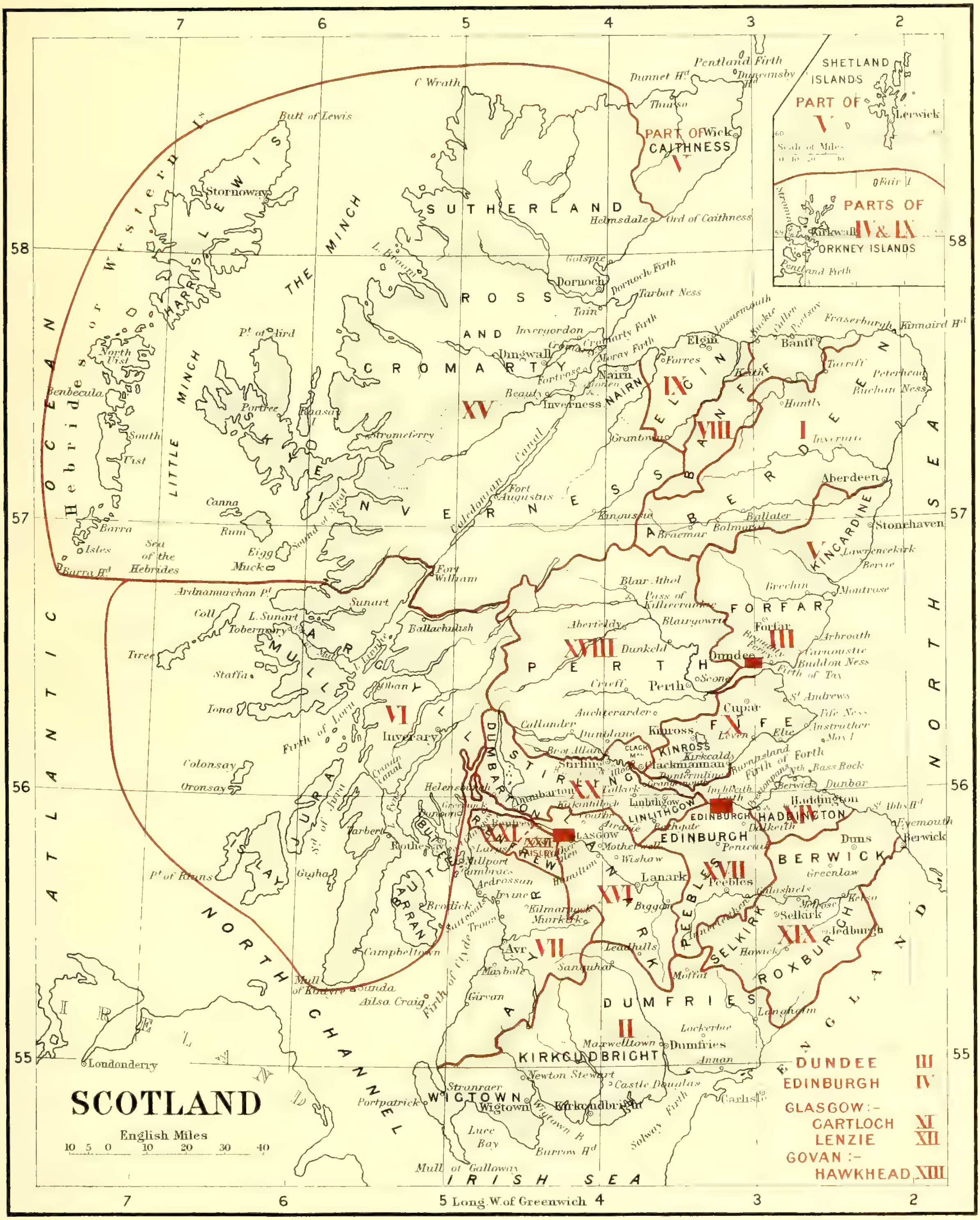
Observations were made on a selection of both measurable and non-measurable characters of inmates. The measurable characters observed and recorded were those of stature (S), head length (L), head breadth (B), and head height (H); the non-measurable characters were those of hair colour, eye colour, and nose contour. Head length was measured from the most prominent point of glabella to the occipital point, and was therefore the maximum head length. The head breadth measured was the maximum breadth above the level of the ear. Head height was taken from the mid points of the auricular passages to the vertex. The types of nose recognised were straight (S), Roman (R), Jewish (J), concave (C), and wavy (W). The categories adopted for hair and eye colours were those used by the author in similar previous observations, and are the categories recognised by authorities in this country. The hair categories were red (R), fair (F), medium (M), dark (D). The letters B and M have, however, been inadvertently used in pages 5 to 14 to describe medium hair (*i.e.* in the Record of Observations on males at Aberdeen, Dumfries, Dundee, Edinburgh, Montrose, and Argyll), otherwise M is used in the hair column to describe medium hair. Red included light, bright, and dark red; fair consisted of white, flaxen, and golden yellow; medium included chestnut and all shades of brown except dark brown; dark embraced dark brown and black. The eye categories were light, medium, and dark (hazel brown). Where blanks occur in the table, no observations were made or recorded. The blanks in hair colour were chiefly due to absence of hair (baldness) or absence of pigment (grey hair).

APPENDIX II.—*Classified Data.*

In Appendix II, one table of frequency and several tables of correlation are given, inclusive of the hair and eye colour table. Where italics occur at the end of the range in any of the tables, a break in the continuity of the scale is indicated. No persons with intermediate dimensions were observed to occur. Tables of means and variabilities are also given in this appendix.

List of Asylums—Key to Map.

Asylum.	Counties in each Area.
I.—Aberdeen Royal Asylum	Aberdeen.
II.—Crichton Royal Institution	Dumfries, Kirkcudbright, Wigtown.
III.—Dundee District Asylum	Dundee.
IV.—Edinburgh Royal Asylum	Edinburgh (City) and Leith.
V.—Montrose Royal Asylum	Forfar, Kincardine, Caithness, Shetland.
VI.—Argyll District Asylum	Argyll, Bute, and Arran.
VII.—Ayr District Asylum	Ayr.
VIII.—Banff District Asylum	Banff.
IX.—Elgin District Asylum	Elgin.
X.—Fife District Asylum	Fife, Kinross.
XI.—Glasgow District Asylum (Gartloch)	Glasgow.
XII.— „ „ „ (Lenzie)	„
XIII.—Govan District Asylum	„
XIV.—Haddington District Asylum	Haddington.
XV.—Inverness District Asylum	Inverness, Nairn, Ross & Cromarty.
XVI.—Lanark District Asylum	Lanark.
XVII.—Midlothian District Asylum	Midlothian, Peebles.
XVIII.—Perth District Asylum	Perth.
XIX.—Roxburgh District Asylum	Berwick, Roxburgh, Selkirk.
XX.—Stirling District Asylum	Stirling, Dumbarton, Clackmannan, and Linlithgow.
XXI.—Greenock Parochial Asylum	Renfrew.
XXII.—Paisley Parochial Asylum	Renfrew.



SCOTLAND
English Miles
10 5 0 10 20 30 40
5 Long. W. of Greenwich 4
SHETLAND ISLANDS
PART OF V
Lerwick
ORKNEY ISLANDS
PARTS OF IV & IX
Kirkwall
Pentland Firth
PART OF CAITHNESS V
Wick
Thurso
Dunnet Hd.
Duncansby Hd.
C. Wrath
Butt of Lewis
Stornoway
LEWIS
HARRIS
North Uist
Benbecula
South Uist
Barra
Barra Hd.
Hebrides or Western Is.
THE MINCH
LITTLE MINCH
SUTHERLAND
Helmsdale
Ord of Caithness
Golspie
Dornoch
Dornoch Firth
Tarbat Ness
Tain
ROSS AND CROMARTY
XV
Invergordon
Cromarty Firth
Dingwall
Moray Firth
Fortrose
Nairn
NAIRN
Beauly
Inverness
SKYE
Portree
Raasay
Strome Ferry
Canna
Rum
Eigg
Muck
Sea of the Hebrides
Sound of Sleat
INVERNESS
Caledonian Canal
Fort Augustus
Fort William
Kingussie
Grantown
Forres
Elgin
Lossiemouth
ELGIN
IX
BANFF
VIII
Keith
Banff
Cullen
Fraserburgh
Kinnaird Hd.
Turriff
Peterhead
Buchan Ness
Huntly
I
Inverurie
ABERDEEN
Aberdeen
Ballater
Braemar
Balmoral
KINCARDINE
V
Stonehaven
Laurencekirk
Bervie
Montrose
Brechin
FORFAR
Forfar
III
Arbroath
Carnoustie
Buddon Ness
Dundee
Firth of Tay
Blair Athol
Pass of Killiecrankie
Blairgowrie
Aberfeldy
XVIII
Dunkeld
PERTH
Perth
Scone
Crieff
Auchterarder
Ardnamurchan Pt.
Sunart
Coll
L. Sunart
Tobermory
Tiree
Staffa
Iona
MULL
ARGYLL
Ballachulish
Oban
VI
Inveraray
Firth of Lorn
Colonsay
Oronsay
JURA
ISLAY
Pt. of Rhins
Sd. of Jura
Tarbert
Crinan Canal
BUTE
Rothesay
ARRAN
Brodick
Campbeltown
Mull of Kintyre
Sanda
Ailsa Craig
Firth of Clyde
ST. ANDREWS
Cupar
FIFE
X
Leven
Elie
Anstruther
Fife Ness
May I.
Kinross
KINROSS
Kirkcaldy
Burntisland
Dunfermline
Firth of Forth
CLACKMANNAN
Clackmannan
Alloa
Callander
Dunblane
Bridge of Allan
Stirling
STIRLING
XX
Falkirk
Grangemouth
Bo'ness
Inchkeith
North Berwick
Bass Rock
Dunbar
Haddington
HADDINGTON
IV
Prestonpans
Leith
EDINBURGH
Dalkeith
Penicuik
Bathgate
LINLITHGOW
Linlithgow
Kirkintilloch
Coatbridge
Airdrie
DUMBARTON
Dumbarton
Helensburgh
Greenock
Dunoon
Renfrew
RENFREW
GLASGOW
XI
XII
PAISLEY
Largs
Millport
Cumbrae
Ardrossan
Irvine
Kilmarnock
Muirkirk
Troon
Ayr
AYR
VII
Maybole
Girvan
Hamilton
Motherwell
Wishaw
LANARK
Lanark
XVI
Biggar
Leadhills
Sanquhar
PEEBLES
XVII
Peebles
Galashiels
Melrose
Kelso
Selkirk
SELKIRK
Hawick
ROXBURGH
XIX
Jedburgh
Moffat
BERWICK
Greenlaw
Duns
Eyemouth
Berwick
St. Abbs Hd.
DUMFRIES
II
Lockerbie
Dumfries
Maxwelltown
Annan
Langholm
KIRKCUDBRIGHT
Kirkcudbright
Newton Stewart
Castle Douglas
Solway Firth
Carlisle
WIGTOWN
Wigtown
Wigtown B.
Stranraer
Portpatrick
Luce Bay
Mull of Galloway
Burrow Hd.
IRISH SEA
NORTH CHANNEL
ATLANTIC OCEAN
NORTH SEA
ENGLAND
IRELAND
Londonderry
DUNDEE III
EDINBURGH IV
GLASGOW:-
CARTLOCH XI
LENZIE XII
GOVAN:-
HAWKHEAD XIII

W. & A. K. Johnston, Limited, Edinburgh & London

I.—Aberdeen Royal Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No	Colour Character		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
1	D	M	S	5	2	130	187	144	61	D	L	R	5	6	140	199	153
2	M	M	S	5	6	138	198	153	62	D	D	R	5	9	134	193	145
3	...	M	S	5	5	128	195	151	63	F	L	S	5	10	134	199	150
4	M	M	S	5	7	134	196	153	64	D	D	S	5	11	128	189	146
5	M	M	S	5	8	132	186	147	**65**	D	M	S	5	10	135	199	155
6	...	M	S	5	5	136	208	159	66	D	L	S	5	4	134	189	148
7	M	M	S	5	5	138	198	158	67	...	L	S	5	5	138	199	156
8	...	L	R	5	6	128	194	149	68	D	D	S	5	9	130	191	151
9	...	..	...	5	9	136	196	153	69	...	D	S	5	4	131	201	155
10	F	M	R	5	3	131	185	145	**70**	...	D	S	5	7	135	189	150
11	D	M	S	5	5	129	186	153	71	D	M	S	5	3	131	202	155
12	...	M	S	5	7	129	198	149	72	D	D	S	5	8	129	207	155
13	D	M	S	...		138	194	154	73	...	M	S	5	6	144	198	161
14	F	L	S	...		144	204	152	74	...	M	S	5	4	129	181	142
15	...	L	S	...		134	196	150	**75**	...	L	S	5	11	128	199	155
16	F	L	R	...		131	191	145	76	...	M	S	5	8	135	194	152
17	M	L	S	...		132	189	149	77	D	M	S	5	1	130	191	152
18	D	D	S	...		133	197	153	78	D	L	S	5	4	132	179	144
19	...	L	S	5	6	132	201	159	79	D	M	S	5	5	142	186	161
20	D	L	S	5	7	131	194	145	**80**	...	M	S	5	10	135	198	159
21	M	M	S	5	7	130	193	145	81	...	D	S	5	10	140	207	159
22	D	M	S	5	8	134	209	155	82	D	M	S	5	9	135	201	165
23	F	M	S	5	6	126	194	149	83	D	D	S	5	3	125	194	150
24	...	L	S	5	6	133	189	151	84	...	M	S	5	5	135	199	148
25	D	M	S	5	6	136	193	149	**85**	...	M	S	5	4	136	189	148
26	...	L	S	5	8	129	192	146	86	D	D	S	5	8	136	184	149
27	...	M	S	5	5	132	204	156	87	D	M	S	5	7	135	196	147
28	M	L	S	5	0	133	192	153	88	D	M	R	5	5	139	196	157
29	...	L	R	5	6	135	189	156	89	D	M	W	5	2	133	193	147
30	F	L	S	5	6	130	189	149	**90**	D	D	S	5	8	142	204	153
31	D	D	S	5	9	139	201	159	91	D	D	S	5	6	144	201	155
32	D	L	S	5	8	134	195	149	92	F	M	S	5	5	129	188	147
33	F	L	R	5	7	138	191	158	93	D	M	S	6	0	131	188	151
34	D	M	C	6	0	142	193	157	94	M	L	S	5	7	134	197	152
35	...	L	S	5	4	142	207	151	**95**	...	M	S	5	6	134	197	154
36	...	M	S	5	0	138	197	152	96	D	M	S	5	4	126	191	145
37	D	D	S	5	3	133	189	145	97	...	L	S	5	5	130	189	148
38	D	D	S	5	9	132	192	159	98	D	D	S	5	5	134	198	149
39	...	L	S	...		122	190	144	99	...	M	S	5	5	129	193	155
40	...	L	W	...		132	193	145	**100**	D	D	S	5	5	134	203	156
41	M	L	S	...		136	195	153	101	D	L	S	5	6	127	188	151
42	...	M	S	...		134	195	151	102	D	L	S	5	11	140	197	150
43	D	M	S	...		135	198	153	103	D	L	S	5	2	133	189	151
44	...	L	S	...		131	196	158	104	M	L	S	5	10	141	198	158
45	...	M	S	...		141	196	154	**105**	D	L	S	5	10	145	201	159
46	...	M	S	...		136	201	149	106	R	L	R	5	8	128	182	152
47	D	M	S	...		140	198	157	107	D	M	S	5	7	137	197	157
48	D	M	S	...		132	186	139	108	M	L	S	5	9	129	198	157
49	...	M	S	..		136	201	155	109	...	M	S	5	6	138	195	158
50	...	M	S	5	2	130	180	150	**110**	M	M	S	5	5	133	194	152
51	D	M	J	5	5	138	187	149	111	M	L	W	5	7	143	193	159
52	N	D	S	5	5	131	192	150	112	M	L	S	5	9	145	204	162
53	D	D	S	5	8	134	192	151	113	D	L	S	5	11	126	196	151
54	D	M	S	5	7	131	201	157	114	M	M	S	5	7	135	193	152
55	M	M	W	5	9	132	192	150	**115**	M	M	S	5	8	143	194	143
56	M	M	S	5	8	131	197	159	116	F	L	S	5	10	137	193	155
57	D	L	S	5	6	126	189	150	117	M	L	S	5	5	131	193	145
58	D	M	S	5	7	132	198	148	118	R	M	S	5	2	133	189	153
59	M	M	S	5	6	134	195	159	119	D	L	S	5	8	130	194	148
60	M	...	S	5	7	130	189	138	**120**	D	L	S	5	10	140	197	157

I.—Aberdeen Royal Asylum.

MALES.

No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
121	M	L	S	5	6	135	182	146
122	M	L	S	5	1	134	184	150
123	D	M	S	5	4	129	186	147
124	M	M	S	4	8	129	185	149
125	M	M	S	5	3	133	183	147
126	M	L	S	5	8	138	198	157
127	D	M	S	5	7	135	201	156
128	..	M	S	5	7	138	199	159
129	.	D	R	5	3	135	198	153
130	M	L	S	5	5	135	190	148
131	M	M	S	5	4	132	190	148
132	M	L	S	5	10	143	201	158
133	M	M	W	5	8	145	199	155
134	M	D	S	5	7	145	188	150
135	...	M	R	5	11	128	196	151
136	M	L	S	5	4	139	192	154
137	M	M	S	5	5	140	203	152
138	F	L	W	5	6	132	194	156
139	N	M	S	5	2	129	184	150
140	N	M	S	5	7	138	197	157
141	D	M	S	5	10	140	197	157
142	...	M	W	5	11	128	194	148
143	M	M	S	5	8	132	192	150
144	M	D	S	5	8	129	197	147
145	M	L	S	5	8	141	200	152
146	...	M	S	5	5	137	196	150
147	M	M	S	5	6	134	191	158
148	D	L	S	5	11	133	193	152
149	D	M	S	5	10	140	188	155
150	R	M	S	5	6	135	194	148
151	D	M	S	5	7	125	189	150
152	M	L	S	5	5	138	189	150
153	D	L	R	5	6	133	190	155
154	M	D	S	5	5	142	198	157
155	F	M	S	6	0	133	194	145
156	D	M	R	5	6	145	205	159
157	N	D	S	5	7	129	189	150
158	...	L	S	5	6	133	184	144
159	..	M	S	5	7	139	187	157
160	M	D	S	5	2	139	191	154
161	D	M	S	5	3	129	183	153
162	D	M	S	5	7	133	201	157
163	D	L	S	5	5	134	194	151
164	...	D	S	5	4	145	192	156
165	M	M	S	5	2	126	181	140
166	D	D	S	5	6	137	188	162
167	D	D	S	5	10	139	194	159
168	D	D	S	5	4	135	187	142
169	D	M	S	6	1	140	196	151
170	...	M	S	5	4	135	193	158
171	M	M	S	5	8	142	195	157
172	B	L	S	5	5	135	197	149
173	...	M	S	5	4	140	190	146
174	M	M	R	5	4	134	193	147
175	...	M	S	5	10	140	209	158
176	D	M	S	5	4	133	184	142
177	D	D	S	6	0	138	193	147
178	...	M	S	5	4	142	205	156
179	D	M	S	5	5	129	189	154
180	M	D	S	5	6	130	188	153

MALES.

No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
181	M	M	W	5	1	138	190	153
182	M	M	S	5	10	137	190	150
183	M	L	S	5	8	137	188	151
184	D	M	S	5	9	145	187	152
185	D	M	S	5	5	138	185	144
186	D	M	S	5	8	135	199	157
187	D	M	S	5	10	139	195	150
188	D	D	S	5	9	143	208	158
189	D	M	S	5	7	142	189	149
190	...	M	S	5	5	143	203	150
191	...	D	S	5	4	136	180	148
192	D	M	S	5	6	131	175	147
193	M	M	W	5	1	138	185	143
194	D	M	S	5	0	140	192	153
195	...	D	S	5	3	145	190	152
196	...	D	R	5	7	144	203	163
197	D	M	W	5	8	139	196	153
198	D	...	...	5	8	129	188	148
199	M	M	S	5	6	134	200	155
200	D	D	R	5	7	135	197	145
201	D	D	S	4	11	135	181	143
202	...	...	W	5	1	131	190	151
203	D	D	S	5	5	138	180	146
204	R	L	S	5	8	133	186	149
205	D	M	S	5	6	131	195	150
206	M	L	W	5	8	140	192	156
207	D	M	S	5	6	140	184	155
208	F	M	W	5	2	145	196	156
209	..	D	S	5	8	145	190	150
210	D	L	C	5	9	145	201	160
211	...	D	S	5	10	141	207	164
212	D	M	W	5	8	132	187	143
213	D	D	S	6	1	153	204	168
214	...	D	S	5	5	134	188	154
215	D	D	R	5	1	141	180	147
216	...	L	S	5	7	142	194	151
217	...	D	S	5	11	134	205	154
218	D	D	S	5	6	139	189	147
219	...	D	S	5	6	140	195	157
220	...	D	S	5	9	136	197	153
221	...	D	S	5	9	140	200	156
222	D	D	W	5	5	139	195	141
223	D	D	S	5	1	134	178	141
224	M	M	S	5	3	140	191	150
225	D	D	W	5	7	139	197	153
226	M	M	S	5	6	145	202	153
227	M	M	R	5	8	151	192	150
228	D	M	S	5	5	128	189	150
229	...	L	R	6	1	139	192	153
230	D	L	W	5	10	144	201	156
231	D	D	C	5	5	138	191	148
232	D	D	S	5	3	145	190	150
233	D	M	S	5	5	143	199	156
234	D	M	S	5	9	134	191	150
235	M	M	S	5	2	129	188	143
236	R	D	S	5	6	137	193	160
237	D	M	S	5	5	134	193	150
238	F	L	S	5	7	141	195	155
239	D	D	S	5	6	144	199	160
240	M	M	S	5	4	129	185	149

I.—Aberdeen Royal Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
241	D	M	J	5	8	132	194	154	278	D	L	S	5	6	135	201	159
242	M	D	S	5	9	138	193	157	279	N	M	S	5	7	121	190	144
243	F	L	S	5	7	137	192	145	**280**	M	L	S	5	2	131	191	153
244	D	D	S	5	8	141	205	158	281	D	D	S	5	7	133	195	156
245	D	D	S	5	5	127	186	149	282	M	L	W	5	5	132	185	151
246	M	M	S	5	9	141	198	146	283	...	D	S	5	5	133	193	156
247	D	M	S	5	7	140	193	154	284	D	M	S	5	6	136	204	157
248	M	M	C	6	0	147	193	150	**285**	D	M	S	5	6	141	189	153
249	M	D	S	5	4	135	194	149	286	D	M	S	5	7	139	201	160
250	M	M	S	5	6	129	190	152	287	F	L	R	5	6	128	188	142
251	D	D	S	5	4	140	186	147	288	...	L	S	5	8	133	189	156
252	R	L	S	5	10	134	201	154	289	...	D	W	5	6	130	201	149
253	D	M	S	5	11	143	194	155	**290**	M	L	S	5	8	132	193	149
254	M	M	S	5	10	135	181	144	291	N	M	S	5	5	134	189	157
255	R	L	S	5	6	135	191	148	292	...	D	W	5	2	144	203	151
256	D	M	S	5	10	136	192	150	293	N	M	S	5	9	144	204	153
257	D	M	S	5	7	141	192	148	294	D	M	S	5	10	135	205	154
258	D	M	S	5	7	134	193	158	**295**	...	M	S	5	6	140	199	157
259	M	D	...	5	3	148	188	149	296	M	M	S	5	5	134	188	147
260	D	L	S	5	6	140	196	151	297	...	M	S	5	10	133	298	153
261	...	M	S	5	6	142	199	149	298	M	M	S	6	0	138	195	164
262	D	M	S	5	4	131	192	151	299	M	M	...	5	7	134	193	149
263	D	L	S	5	7	139	195	154	**300**	M	M	S	5	4	144	201	152
264	M	M	S	5	6	133	192	149	301	...	D	R	5	3	128	197	149
265	D	M	S	5	2	130	193	154	302	D	D	S	5	8	123	188	148
266	D	D	S	5	5	133	197	156	303	...	M	S	5	2	132	189	148
267	D	M	S	5	8	135	194	159	304	M	L	S	5	7	130	186	142
268	M	M	S	5	6	139	207	159	**305**	...	D	S	5	8	134	191	153
269	M	M	S	5	11	138	202	153	306	...	L	S	5	4	131	196	153
270	N	L	S	5	6	132	189	153	307	...	M	S	5	5	135	204	160
271	M	M	C	5	3	133	201	150	308	R	M	S	6	1	139	192	150
272	..	D	S	5	5	145	201	165	309	...	M	S	5	5	128	197	145
273	M	L	S	5	5	134	185	152	**310**	F	L	S	5	8	143	193	152
274	D	M	S	5	5	136	195	157	311	M	M	S	5	7	145	208	159
275	D	M	S	5	6	144	194	157	312	M	L	S	5	6	133	198	148
276	D	L	S	5	4	140	198	156	313	...	M	S	5	5	129	192	157
277	M	D	C	5	7	136	195	156	314	...	L	S	5	6	141	193	151

II.—Crichton Royal Institution.

MALES.									MALES.								
1	B	L	W	5	8	135	186	147	16	B	L	S	5	7	144	208	166
2	B	M	W	5	6	137	207	151	17	B	L	S	5	6	141	199	149
3	B	D	S	5	9	138	206	151	18	B	M	S	5	5	134	186	145
4	B	L	S	5	6	138	203	159	19	B	L	S	5	8	135	211	153
5	B	L	S	5	6	138	194	151	**20**	B	M	S	5	7	127	188	147
6	B	L	W	5	9	138	194	146	21	B	D	S	5	4	130	193	156
7	B	M	S	5	6	135	199	147	22	B	L	S	5	5	130	191	151
8	B	D	S	5	3	137	182	147	23	B	M	S	5	4	133	193	153
9	B	M	R	5	5	130	197	153	24	B	L	W	5	10	133	199	157
10	B	M	S	5	5	141	188	162	**25**	B	L	S	5	4	132	210	156
11	B	L	S	5	8	144	199	158	26	B	L	S	5	5	135	201	151
12	F	L	S	5	8	136	193	158	27	D	D	S	5	9	138	196	146
13	B	L	S	5	7	141	199	156	28	B	L	S	5	7	133	189	157
14	B	L	W	5	3	138	193	149	29	B	L	S	5	6	132	189	146
15	B	L	S	5	4	127	188	135	**30**	B	L	S	5	9	130	200	149

II.—Crichton Royal Institution.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
31	B	L	S	5	10	135	206	153	73	B	L	S	5	8	131	193	144
32	B	D	S	5	10	139	200	152	74	B	L	S	5	3	132	184	143
33	D	L	S	5	7	136	196	149	**75**	D	M	R	4	9	125	178	139
34	D	L	S	5	8	139	201	157	76	B	L	W	5	5	134	200	154
35	B	L	S	5	6	138	193	153	77	B	M	S	5	8	134	195	149
36	B	L	S	5	9	135	193	154	78	B	D	S	5	8	139	201	153
37	B	M	S	5	5	132	194	148	79	B	L	S	5	11	142	209	146
38	B	L	S	5	5	143	213	162	**80**	B	L	S	5	5	144	202	157
39	B	L	S	5	6	139	199	143	81	B	L	S	5	7	131	191	145
40	D	L	S	5	10	143	203	154	82	B	L	S	5	8	133	193	147
41	B	L	S	5	8	132	203	154	83	B	L	S	5	5	125	189	144
42	B	M	S	5	9	134	207	148	84	B	L	S	5	0	131	201	149
43	B	L	S	5	6	135	193	150	**85**	D	D	S	5	11	132	207	159
44	B	L	W	5	11	138	197	149	86	B	M	S	5	7	132	196	152
45	B	M	C	5	10	133	197	151	87	B	L	S	5	4	126	192	151
46	F	L	S	5	5	131	192	142	88	B	L	S	5	4	126	181	148
47	D	L	S	5	7	132	198	156	89	B	L	S	5	4	128	195	149
48	B	L	W	5	7	139	191	161	**90**	B	M	S	5	7	130	211	156
49	B	L	S	5	6	136	188	155	91	B	M	S	5	3	138	211	151
50	B	M	S	5	6	135	197	156	92	D	D	S	6	0	139	200	157
51	B	L	W	5	11	136	205	150	93	B	L	S	5	5	142	198	153
52	B	M	S	5	3	125	188	146	94	B	L	S	5	0	132	195	145
53	B	M	S	5	0	128	191	149	**95**	B	L	S	5	8	131	195	149
54	B	M	S	5	7	134	194	149	96	D	M	S	5	7	128	191	153
55	B	L	S	5	9	137	195	149	97	B	L	S	4	1	129	197	149
56	B	L	S	5	5	137	191	144	98	B	L	S	5	4	131	203	155
57	B	L	S	5	8	138	206	159	99	B	L	S	5	7	138	200	148
58	B	L	S	5	6	129	197	156	**100**	B	L	S	5	2	132	195	140
59	D	D	S	5	1	133	188	142	101	B	M	S	5	3	133	200	156
60	D	D	R	5	1	130	197	153	102	B	L	S	5	1	131	174	138
61	B	M	S	5	6	128	194	149	103	B	L	S	5	8	136	211	163
62	B	L	S	5	5	137	195	149	104	D	M	S	5	2	136	201	148
63	B	L	W	5	9	146	210	168	**105**	B	L	S	5	2	135	189	153
64	B	L	S	5	6	139	192	149	106	B	M	S	5	5	140	193	150
65	B	M	S	5	10	135	205	163	107	B	L	S	5	3	140	190	147
66	B	L	R	5	9	143	198	151	108	D	D	S	5	8	137	200	156
67	D	L	S	5	3	142	194	155	109	B	M	S	5	3	135	188	137
68	B	L	S	5	5	148	205	160	**110**	B	L	S	5	1	131	181	140
69	B	M	S	5	8	148	199	163	111	F	D	S	5	0	135	186	151
70	D	M	S	5	5	132	189	147	112	B	D	W	5	6	136	203	156
71	B	L	W	5	9	133	202	148	113	F	L	S	5	2	129	187	156
72	B	L	S	5	6	141	195	155									

III.—Dundee District Asylum.

MALES.									MALES.								
1	B	L	S	5	2	133	202	153	11	B	L	S	5	6	132	188	148
2	B	L	S	5	8	132	198	154	12	F	L	S	5	4	121	191	152
3	B	M	S	5	6	133	199	157	13	B	M	S	5	9	133	197	156
4	B	L	S	5	7	133	195	145	14	B	L	S	5	3	133	191	144
5	B	M	C	5	9	129	188	143	**15**	B	L	W	5	6	131	193	133
6	B	L	S	5	8	133	201	160	16	B	L	S	5	6	134	196	144
7	R	M	R	5	5	131	183	147	17	D	L	S	5	7	134	193	151
8	B	L	S	5	7	133	193	156	18	B	M	S	5	9	142	203	156
9	B	L	S	5	8	135	202	156	19	B	L	S	5	6	137	191	147
10	B	L	S	5	6	135	197	153	**20**	B	M	S	5	11	132	192	156

III.—Dundee District Asylum.

MALES.

No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
21	B	M	S	5	6	130	183	143
22	B	L	W	5	4	127	188	151
23	B	L	S	5	4	133	193	151
24	B	M	S	5	4	129	185	146
25	D	L	S	5	4	132	189	152
26	D	L	S	5	7	134	202	153
27	B	D	S	5	6	136	200	155
28	D	L	S	5	5	130	195	153
29	B	M	W	5	6	143	212	163
30	B	L	S	5	5	139	192	156
31	B	L	S	5	6	130	188	152
32	B	L	S	5	6	135	195	159
33	B	M	S	5	4	131	195	160
34	B	L	S	5	8	137	203	149
35	D	L	S	5	8	135	198	154
36	D	L	S	5	10	135	199	154
37	B	L	R	5	7	130	200	156
38	B	M	R	5	6	131	198	148
39	B	L	S	5	4	137	207	156
40	F	L	S	5	4	130	183	151
41	B	L	W	5	11	128	188	140
42	D	L	S	5	6	128	185	149
43	B	L	W	5	4	124	195	146
44	B	M	W	5	3	136	196	155
45	B	L	W	5	8	136	204	155
46	B	M	S	5	4	125	181	146
47	B	M	S	5	6	128	192	149
48	B	L	S	5	1	134	200	154
49	B	M	S	5	8	133	196	151
50	B	L	W	5	6	136	202	160
51	B	L	S	5	7	132	193	152
52	B	L	S	5	3	139	199	154
53	B	L	S	5	2	142	198	146
54	D	D	W	5	6	136	189	152
55	B	L	S	5	4	132	184	152
56	B	M	S	5	7	133	192	151
57	F	M	S	5	5	142	208	156
58	B	L	S	5	5	138	184	159
59	B	M	S	5	5	136	194	154
60	B	M	S	5	5	128	192	148
61	B	L	C	5	7	132	196	159
62	B	L	S	5	7	135	188	157
63	B	L	S	5	1	130	195	152
64	D	D	S	5	1	139	196	158
65	B	L	R	5	4	134	200	151
66	B	D	S	5	6	138	194	165
67	D	M	S	5	3	134	185	158
68	F	L	S	5	7	135	204	146
69	B	L	S	5	2	135	194	156
70	B	M	S	5	4	137	196	153
71	B	L	S	5	6	136	198	148
72	B	M	S	4	11	130	168	140
73	B	L	S	5	4	133	195	148
74	B	M	S	5	4	131	195	148
75	B	L	S	5	6	139	204	162
76	B	L	S	5	3	135	193	151
77	B	L	S	5	10	139	200	160
78	B	L	R	5	7	138	198	155
79	B	M	S	5	8	140	203	160
80	B	M	W	5	10	137	192	156
81	B	D	C	5	6	133	194	155

MALES.

No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
82	B	M	S	5	8	138	186	155
83	B	M	S	4	2	134	187	155
84	B	L	S	5	4	124	192	146
85	B	D	S	5	3	135	196	152
86	B	D	S	5	4	133	197	149
87	D	L	S	5	10	135	198	154
88	B	L	S	5	6	133	205	144
89	D	M	S	5	6	136	212	163
90	B	L	S	5	10	138	211	162
91	B	L	S	5	7	133	195	158
92	B	M	S	5	5	134	197	153
93	B	L	S	5	5	126	192	149
94	D	..	S	5	7	138	204	146
95	M	...	S	5	10	139	203	151
96	L	...	S	5	8	135	185	148
97	L	...	S	5	4	135	203	155
98	D	F	...	5	2	139	196	150
99	D	D	S	5	7	139	205	150
100	B	F	S	5	6	136	204	154
101	B	L	S	5	8	141	192	154
102	D	M	S	5	4	138	195	155
103	B	M	S	5	6	140	202	163
104	B	M	S	5	6	135	191	153
105	B	L	S	5	4	132	193	149
106	B	D	W	5	3	126	191	145
107	B	L	S	5	6	132	193	153
108	F	L	S	5	4	133	195	152
109	D	L	S	5	6	131	180	140
110	B	L	S	5	2	133	181	142
111	B	L	S	5	6	132	196	153
112	N	L	S	5	1	129	186	148
113	B	L	S	5	2	138	217	159
114	B	L	S	5	6	132	189	149
115	B	M	S	5	6	135	197	152
116	B	L	S	5	6	132	186	143
117	B	L	S	5	4	131	185	143
118	F	L	W	5	3	143	197	151
119	B	L	S	5	5	140	203	152
120	B	M	S	5	5	140	199	152
121	B	M	R	5	8	126	190	151
122	B	M	S	5	2	124	193	145
123	B	L	S	5	0	120	189	147
124	B	M	S	4	11	132	183	147
125	F	D	S	5	4	134	192	155
126	B	D	S	5	9	133	212	155
127	D	M	S	5	4	135	194	155
128	B	F	S	6	3	132	207	162
129	B	L	S	5	4	144	207	155
130	B	L	S	5	1	137	197	170
131	B	M	S	5	1	131	196	152
132	B	L	S	5	7	127	191	147
133	B	D	W	5	7	135	193	150
134	B	L	S	5	2	134	188	150
135	B	L	S	5	2	134	199	152
136	B	L	S	5	5	132	192	146
137	B	D	S	5	5	134	193	148
138	D	L	S	5	5	132	201	160
139	B	L	S	5	6	136	192	152
140	D	L	S	5	5	138	187	152
141	B	M	S	5	9	130	194	158

IV.—Edinburgh Royal Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.				H.	L.	B.		Hair.	Eyes.				H.	L.	B.
				ft.	in.	mm.	mm.	mm.					ft.	in.	mm.	mm.	mm.
1	B	L	S	5	2	125	202	152	61	D	M	S	5	6	147	191	153
2	B	L	S	5	6	147	199	149	62	F	L	W	5	5	137	194	143
3	B	L	S	5	7	138	196	154	63	B	M	S	4	11	134	186	142
4	D	D	S	5	3	142	189	145	64	B	L	S	5	6	142	197	148
5	D	D	W	5	3	136	192	141	**65**	F	L	R	5	8	148	190	151
6	B	L	W	5	5	137	194	156	66	D	L	S	5	7	139	205	152
7	D	M	S	5	3	141	190	151	67	D	D	S	5	3	132	192	150
8	B	D	S	5	5	141	194	148	68	B	L	S	6	0	147	207	155
9	B	L	W	5	9	141	206	156	69	B	L	S	5	2	141	190	142
10	B	L	S	5	11	159	203	157	**70**	B	L	S	5	5	142	197	151
11	D	L	S	4	11	128	178	141	71	B	L	S	5	4	142	192	148
12	B	D	S	5	4	130	194	152	72	F	L	W	5	3	134	186	154
13	D	M	S	5	7	143	194	147	73	B	M	S	5	3	135	196	147
14	B	L	S	5	5	137	184	148	74	D	D	S	5	4	132	183	140
15	B	L	S	5	3	136	187	154	**75**	B	L	S	6	2	141	192	149
16	D	L	S	5	2	136	201	149	76	D	M	S	5	6	144	199	152
17	B	D	W	5	10	141	204	148	77	B	M	S	5	7	137	194	148
18	N	D	S	5	9	141	200	154	78	B	L	S	5	11	144	192	153
19	F	L	S	4	11	158	202	162	79	B	L	S	5	5	140	192	152
20	D	L	S	5	7	137	194	152	**80**	D	M	S	5	4	141	197	148
21	W	L	S	5	6	142	189	149	81	D	D	S	6	0	137	202	152
22	F	L	R	4	11	134	180	143	82	D	M	S	5	8	131	189	148
23	B	L	S	...		147	191	156	83	B	D	S	5	7	138	194	159
24	D	D	S	5	6	149	196	149	84	B	D	S	5	7	136	196	157
25	B	D	S	5	2	137	194	148	**85**	B	L	W	5	8	141	196	153
26	B	M	S	5	4	137	197	154	86	B	L	S	5	5	140	200	151
27	D	D	S	5	6	147	201	159	87	D	L	S	6	0	135	204	157
28	D	D	S	5	5	141	195	153	88	B	M	S	5	10	140	205	153
29	B	L	S	5	7	143	197	151	89	B	D	S	5	3	132	184	142
30	B	L	R	5	8	146	190	155	**90**	B	L	S	5	6	133	186	144
31	B	L	S	5	3	140	192	154	91	D	D	S	5	4	129	186	151
32	B	L	S	5	7	136	192	152	92	F	M	S	5	4	138	196	150
33	B	M	W	5	6	137	203	157	93	B	L	S	5	7	140	200	148
34	B	L	W	5	6	143	186	148	94	B	M	S	5	10	132	191	151
35	N	D	S	5	1	142	187	161	**95**	D	D	S	5	5	140	191	147
36	B	L	W	5	6	143	196	160	96	D	D	S	5	8	159	199	140
37	N	L	W	5	6	137	193	157	97	M	D	S	5	9	136	191	154
38	B	M	S	5	7	129	194	153	98	B	L	S	5	7	130	189	150
39	D	L	S	5	6	137	197	154	99	B	D	S	6	1	144	196	154
40	D	L	S	5	6	139	187	142	**100**	B	L	S	5	5	142	195	161
41	N	D	S	5	10	140	189	145	101	B	L	S	5	4	142	187	147
42	B	L	S	5	8	140	189	149	102	N	M	S	5	6	151	204	157
43	M	B	S	5	3	134	187	157	103	N	D	S	5	6	136	194	147
44	D	L	W	5	7	151	198	154	104	B	D	S	5	8	140	189	141
45	D	D	S	5	4	136	197	147	**105**	N	D	S	5	7	143	199	149
46	D	D	S	5	7	135	188	148	106	D	M	S	5	6	139	200	150
47	B	L	R	5	3	144	198	149	107	B	D	S	5	4	136	182	147
48	B	L	S	5	5	137	190	150	108	B	L	S	5	2	137	189	161
49	R	L	S	5	6	132	189	140	109	B	M	S	5	9	132	179	145
50	D	D	W	5	6	138	191	142	**110**	D	D	S	5	4	142	198	162
51	F	L	S	5	7	134	190	158	111	D	D	S	5	5	132	205	154
52	M	L	S	5	4	142	191	149	112	D	M	S	5	7	137	196	158
53	D	D	S	5	4	135	196	147	113	D	D	S	5	4	143	201	150
54	B	L	W	5	6	136	196	156	114	D	M	S	5	5	140	197	152
55	B	D	S	5	6	144	194	156	**115**	D	M	S	5	5	159	194	154
56	B	L	S	5	9	153	197	152	116	D	D	R	5	4	138	186	141
57	F	D	S	5	6	153	197	157	117	F	D	W	5	8	140	196	150
58	B	M	W	5	4	138	200	149	118	B	L	S	5	9	150	207	167
59	B	M	R	5	9	140	196	152	119	B	M	S	5	5	142	190	144
60	D	L	S	5	9	150	202	157	**120**	N	D	W	5	4	133	182	142

IV.—Edinburgh Royal Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
121	R	L	S	5	7	136	196	146	152	F	D	S	5	2	130	194	152
122	B	L	S	5	7	148	188	160	153	D	L	S	5	11	150	207	149
123	D	D	S	5	9	152	201	147	154	F	M	S	5	5	146	204	154
124	B	L	S	5	2	124	185	145	**155**	B	M	S	5	4	136	196	154
125	B	L	S	5	4	136	193	149	156	B	M	S	5	2	139	190	151
126	B	L	S	5	5	138	195	160	157	B	L	S	4	6	135	189	145
127	B	L	S	5	5	134	198	144	158	B	L	S	5	3	143	199	155
128	B	D	S	5	10	138	197	146	159	F	L	S	6	0	130	174	138
129	D	M	S	5	9	143	203	151	**160**	B	L	S	5	6	137	197	152
130	B	L	S	5	10	136	209	157	161	B	D	S	5	0	138	191	143
131	B	L	S	5	4	146	202	157	162	B	L	S	5	5	138	190	153
132	D	D	W	5	7	145	203	148	163	B	L	S	5	9	142	201	156
133	D	M	S	5	5	137	195	153	164	B	L	W	5	5	130	196	147
134	B	D	S	5	9	143	199	154	**165**	B	L	S	5	4	151	192	153
135	B	M	S	5	8	144	199	150	166	B	D	S	6	0	144	202	151
136	D	L	W	5	5	141	198	153	167	N	L	W	5	4	136	194	153
137	B	L	S	5	4	135	195	152	168	R	L	S	5	10	144	201	152
138	B	D	S	5	5	142	197	148	169	D	D	S	5	3	135	200	153
139	B	L	S	5	9	139	196	149	**170**	D	D	S	5	4	145	199	151
140	B	L	W	5	9	137	199	166	171	B	M	S	5	5	145	187	142
141	N	L	S	5	3	142	200	153	172	D	M	S	5	7	140	203	159
142	W	L	S	5	6	142	206	156	173	F	L	W	5	8	144	194	146
143	B	W	W	5	6	147	198	150	174	B	L	S	5	6	127	182	148
144	N	L	S	5	8	145	187	154	**175**	B	M	S	5	4	131	190	149
145	D	D	S	5	5	146	198	154	176	F	L	S	5	3	137	192	148
146	D	L	S	5	4	147	191	144	177	B	M	W	5	5	143	198	163
147	B	L	W	5	10	141	208	154	178	B	L	S	5	2	140	189	154
148	F	L	S	5	10	151	194	156	179	D	L	S	5	5	138	211	160
149	D	D	W	5	2	145	187	150	**180**	D	L	S	5	0	130	196	147
150	F	L	S	5	6	131	185	151	181	B	L	S	5	8	138	196	156
151	N	D	S	5	7	136	199	143									

V.—Montrose Royal Asylum.

MALES.									MALES.								
1	M	L	S	5	1	128	179	142	21	D	L	S	5	4	142	187	161
2	F	D	S	5	4	142	192	152	22	F	L	S	5	5	145	204	149
3	M	L	S	5	4	121	175	142	23	F	L	S	5	8	145	197	155
4	D	M	S	5	9	132	187	146	24	D	D	S	5	5	141	198	158
5	D	M	S	4	10	137	196	154	**25**	F	M	S	5	4	144	199	161
6	B	L	S	5	6	147	191	151	26	F	D	R	5	6	147	200	157
7	F	M	S	5	7	144	200	156	27	M	L	S	5	5	132	192	147
8	M	L	S	5	5	131	196	149	28	F	L	S	5	6	147	201	161
9	D	D	S	5	5	135	200	155	29	B	L	S	5	6	131	190	150
10	F	M	S	5	9	142	208	155	**30**	F	M	S	5	11	140	199	159
11	M	M	S	5	5	126	182	144	31	M	D	S	5	3	139	191	152
12	M	L	S	5	6	145	208	156	32	M	M	S	5	3	137	194	153
13	D	D	S	5	7	138	195	158	33	M	M	S	5	10	152	201	153
14	D	M	S	5	5	138	196	158	34	M	D	C	5	4	145	191	146
15	D	D	S	5	8	134	196	151	**35**	F	D	S	5	8	133	202	148
16	D	M	S	5	6	146	195	153	36	D	D	S	5	6	146	204	160
17	D	M	S	5	6	146	198	158	37	D	L	S	5	5	136	191	148
18	M	L	S	5	4	129	189	155	38	D	M	S	5	3	138	187	144
10	D	M	S	5	6	136	191	152	39	F	L	S	5	4	150	198	159
20	D	M	S	5	8	127	196	152	**40**	M	L	S	5	10	139	195	153

V.—Montrose Royal Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
41	F	M	S	5	10	154	194	148	101	D	D	S	5	7	127	190	148
42	D	M	S	5	2	134	192	152	102	F	D	W	5	10	139	200	161
43	M	L	S	5	2	140	190	156	103	D	D	S	5	10	148	203	153
44	D	D	S	4	0	129	188	144	104	D	D	W	5	0	131	193	157
45	F	L	S	5	8	134	195	146	**105**	D	D	W	5	6	137	196	155
46	F	D	S	4	9	137	198	156	106	R	L	C	5	5	138	199	150
47	D	D	S	5	5	142	201	164	107	D	M	S	5	5	137	190	149
48	F	M	C	5	3	140	208	155	108	F	L	S	5	7	142	200	157
49	...	L	S	5	3	139	185	154	109	D	D	S	5	4	140	195	155
50	R	L	W	5	6	142	194	145	**110**	F	L	S	5	3	142	201	158
51	D	D	S	5	7	140	198	155	111	D	D	S	5	7	143	195	144
52	...	D	S	5	4	140	205	155	112	F	M	S	5	6	159	202	161
53	M	M	S	5	4	130	192	156	113	D	D	R	5	11	134	198	152
54	M	M	S	5	2	134	185	145	114	F	M	S	6	0	142	191	146
55	...	L	S	5	9	140	195	146	**115**	D	M	W	5	6	133	182	154
56	...	L	S	5	4	142	195	148	116	D	D	S	5	3	134	198	145
57	M	M	S	5	8	145	197	152	117	M	M	W	5	3	133	183	152
58	D	L	S	5	7	141	201	159	118	D	L	S	5	5	130	188	147
59	F	M	S	5	3	132	196	149	119	M	M	S	5	4	133	205	156
60	M	D	S	5	11	146	201	150	**120**	D	D	S	5	5	134	183	154
61	M	D	S	5	5	144	198	149	121	F	M	S	5	8	138	195	155
62	B	L	S	5	3	138	192	156	122	D	D	S	5	7	145	203	158
63	M	L	S	5	10	141	190	156	123	D	L	S	5	7	134	183	147
64	D	D	S	5	6	140	198	159	124	D	D	S	5	7	147	200	158
65	F	M	S	5	7	135	199	151	**125**	D	D	W	5	4	136	204	156
66	F	M	S	5	8	134	193	146	126	M	L	S	5	3	130	189	146
67	F	D	S	5	6	138	190	154	127	F	L	R	5	7	133	191	153
68	D	D	S	5	4	139	203	155	128	D	D	S	6	0	135	200	157
69	D	L	S	5	2	140	202	153	129	F	M	S	5	5	135	204	151
70	F	L	S	5	6	140	192	148	**130**	F	M	W	5	6	140	196	157
71	D	D	S	5	6	134	194	153	131	D	D	S	5	4	140	196	143
72	F	L	S	5	6	134	186	152	132	F	D	S	5	8	140	195	154
73	F	M	S	5	4	150	196	158	133	F	M	S	5	9	130	192	158
74	D	D	S	5	5	151	191	161	134	M	M	S	5	8	136	193	150
75	M	M	S	5	5	140	198	147	**135**	F	L	S	5	9	140	201	166
76	M	M	W	5	4	132	194	151	136	F	L	S	5	7	143	199	156
77	M	D	S	5	4	149	197	157	137	F	D	S	5	6	153	187	157
78	F	L	S	5	5	139	193	149	138	F	L	S	5	6	140	200	151
79	M	L	S	5	5	143	197	149	139	D	M	S	5	6	140	195	151
80	M	D	S	5	6	127	187	154	**140**	D	M	S	5	6	141	204	156
81	F	L	R	5	8	145	202	151	141	F	M	R	5	8	157	197	154
82	F	L	S	5	7	142	194	152	142	F	L	S	5	10	145	208	155
83	F	L	R	6	0	145	194	150	143	D	L	S	5	6	131	190	152
84	D	D	S	5	5	129	184	154	144	F	M	W	5	10	147	204	151
85	F	L	S	5	10	141	185	146	**145**	F	L	S	5	8	137	190	146
86	F	D	S	5	8	142	198	163	146	S	D	S	5	9	143	201	164
87	F	D	S	5	6	145	201	147	147	M	D	S	5	9	135	201	152
88	M	D	W	5	3	135	191	148	148	F	M	S	5	4	139	186	147
89	F	L	S	5	5	135	192	146	149	M	L	W	5	9	135	197	154
90	F	M	S	5	9	131	203	155	**150**	D	D	W	5	4	129	189	142
91	R	L	S	5	8	148	197	155	151	M	M	S	5	5	139	205	152
92	D	D	S	5	7	140	193	147	152	D	M	S	5	7	151	201	151
93	D	L	S	5	7	126	191	145	153	F	L	S	5	6	140	199	166
94	M	M	W	5	9	135	193	149	154	D	L	S	5	10	150	206	149
95	D	M	S	5	9	141	195	159	**155**	D	M	W	5	10	150	202	154
96	D	D	S	5	10	137	192	156	156	F	L	W	5	6	133	190	155
97	D	M	S	5	4	140	199	155	157	M	L	S	5	6	140	197	151
98	D	M	S	5	9	133	185	147	158	M	L	S	5	6	140	203	149
99	M	M	R	5	8	147	192	153	159	D	D	R	5	5	136	187	155
100	D	D	S	5	5	144	196	153	**160**	D	M	S	5	6	142	189	150

V.—Montrose Royal Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
161	F	L	S	5	10	142	202	157	208	F	L	S	5	7	138	188	148
162	M	L	S	5	2	134	183	142	209	F	L	S	5	7	148	203	153
163	D	D	S	5	5	141	192	151	**210**	M	M	S	5	6	135	193	146
164	D	L	S	5	8	146	195	151	211	M	L	W	...		145	202	159
165	F	L	S	5	4	148	200	159	212	M	L	S	5	0	135	184	143
166	D	L	S	5	10	142	186	157	213	D	D	S	5	7	135	195	152
167	D	D	S	5	1	134	191	147	214	M	M	S	5	7	140	190	159
168	D	D	S	5	6	144	200	152	**215**	R	M	S	5	7	139	188	151
169	D	L	S	5	7	133	191	155	216	M	L	S	5	9	148	186	152
170	M	D	S	5	7	142	205	158	217	M	L	W	5	6	138	198	152
171	M	D	S	5	4	137	194	149	218	D	D	S	5	5	137	192	159
172	D	M	S	5	7	137	190	144	219	F	M	S	5	10	144	197	157
173	D	D	W	5	4	136	192	152	**220**	F	L	S	5	4	134	201	149
174	F	M	S	5	6	139	194	154	221	F	L	S	5	2	141	198	148
175	D	D	S	5	7	143	201	152	222	F	M	S	5	6	135	194	157
176	D	D	S	5	9	153	203	164	223	M	M	S	5	4	129	177	150
177	F	D	S	5	2	139	186	148	224	F	M	W	5	4	152	193	148
178	F	M	S	5	4	138	185	151	**225**	D	M	S	5	10	147	195	157
179	D	M	W	6	0	146	199	152	226	M	D	S	5	7	136	200	156
180	M	L	S	5	10	138	205	150	227	M	M	S	5	3	140	198	159
181	D	L	R	5	6	140	191	153	228	M	M	W	5	6	139	185	150
182	F	L	S	5	9	139	197	158	229	D	D	S	5	8	149	194	153
183	M	D	S	5	6	140	198	162	**230**	M	M	S	5	2	136	192	150
184	M	D	R	5	7	148	202	145	231	M	M	S	5	5	134	197	150
185	D	M	S	6	0	148	209	159	232	M	M	S	5	5	150	193	154
186	D	D	R	5	9	135	199	154	233	F	L	C	5	8	141	197	157
187	M	M	S	5	7	145	196	165	234	M	L	W	5	9	140	205	150
188	M	L	S	5	8	143	193	159	**235**	D	D	S	5	10	149	200	152
189	D	D	S	5	4	134	195	154	236	M	M	W	5	8	140	203	159
190	F	M	S	5	6	134	188	149	237	D	D	S	5	10	140	192	150
191	F	M	S	5	5	146	203	148	238	M	M	W	5	7	140	200	143
192	D	D	S	5	6	143	195	151	239	M	M	W	5	8	150	191	157
193	D	D	S	5	3	142	200	155	**240**	D	D	W	5	10	147	200	155
194	D	D	W	5	5	146	200	157	241	F	L	W	5	5	144	201	155
195	M	D	S	6	0	142	195	157	242	D	M	S	5	8	133	190	147
196	D	L	W	5	9	139	203	156	243	M	M	S	5	6	129	182	150
197	D	M	S	5	8	129	182	142	244	F	L	S	5	5	131	191	140
198	M	M	S	5	8	146	196	152	**245**	M	M	S	6	0	145	200	151
199	D	M	S	5	5	140	191	153	246	D	D	W	5	5	135	183	156
200	M	M	S	5	6	134	184	148	247	M	L	S	5	9	139	194	165
201	D	D	S	5	4	136	188	151	248	D	D	S	5	8	139	193	156
202	M	M	S	5	0	135	185	144	249	F	L	W	5	6	140	188	153
203	D	M	S	5	5	126	178	143	**250**	D	D	S	5	6	140	189	159
204	M	M	S	5	6	139	202	152	251	D	D	S	5	8	142	201	159
205	M	M	S	5	5	145	186	147	252	M	M	S	5	7	137	198	157
206	M	D	S	5	0	132	182	145	253	R	M	S	5	6	134	198	154
207	F	L	S	5	8	140	199	152	254	M	L	S	5	6	137	188	161

VI.—Argyll District Asylum.

MALES.									MALES.								
1	B	D	S	5	4	131	189	151	6	B	L	S	5	4	132	196	158
2	B	L	W	5	8	138	187	151	7	B	L	S	5	4	132	186	153
3	B	M	S	5	10	138	202	153	8	B	L	S	5	6	140	210	153
4	B	L	S	5	6	134	204	153	9	B	L	S	5	6	131	191	146
5	B	L	S	5	7	133	199	141	**10**	B	L	W	5	8	131	202	158

VI.—Argyll District Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
11	B	M	W	5	8	142	200	151	71	D	L	S	5	1	133	188	140
12	B	N	S	5	6	139	203	156	72	D	D	S	5	5	125	195	141
13	B	D	S	5	5	134	189	148	73	D	L	W	5	5	128	194	142
14	B	D	S	5	9	134	208	156	74	B	L	S	5	6	141	210	164
15	B	M	W	5	10	140	202	153	**75**	B	L	S	5	6	145	201	163
16	B	M	S	5	7	137	200	158	76	B	M	S	5	4	144	200	154
17	B	M	S	5	7	138	197	153	77	B	L	S	5	4	141	204	152
18	B	M	S	5	10	137	205	152	78	B	D	S	5	6	139	201	155
19	B	L	C	5	4	140	196	148	79	B	L	S	5	5	155	216	160
20	B	D	S	5	5	138	211	154	**80**	B	M	W	5	7	132	190	147
21	B	L	S	5	6	134	194	153	81	B	D	A	5	5	138	199	150
22	B	L	S	5	2	133	197	152	82	B	M	S	5	6	136	194	152
23	B	L	S	5	6	133	195	152	83	B	L	S	5	6	136	194	157
24	B	M	S	5	8	136	202	149	84	B	L	S	5	5	144	199	143
25	B	L	W	5	6	138	199	160	**85**	B	L	S	5	7	138	199	159
26	B	D	S	5	10	135	201	159	86	B	M	S	5	8	139	208	152
27	D	L	S	5	4	136	203	151	87	B	M	S	5	5	138	192	154
28	B	M	S	5	4	132	195	156	88	B	M	S	5	7	135	199	153
29	B	M	S	5	10	137	213	157	89	B	L	S	5	6	136	204	150
30	B	L	S	5	4	138	201	152	**90**	B	M	S	5	6	132	195	150
31	B	M	S	5	7	135	201	157	91	B	L	S	5	5	127	183	139
32	B	D	S	5	10	136	207	156	92	B	L	S	5	9	136	195	152
33	B	D	S	5	7	139	216	164	93	B	L	S	5	7	137	199	160
34	D	D	S	5	5	137	203	155	94	B	L	S	5	5	129	183	149
35	B	D	S	5	8	144	210	166	**95**	B	L	S	5	6	131	193	153
36	B	L	S	5	7	130	197	159	96	B	L	S	5	6	133	199	150
37	B	M	R	6	1	134	203	153	97	B	M	S	5	7	136	195	158
38	B	M	S	5	6	131	192	148	98	B	L	S	5	10	133	200	143
39	B	M	S	5	10	142	190	152	99	B	M	S	5	10	130	200	152
40	B	L	S	6	2	134	196	155	**100**	B	L	S	5	8	135	197	155
41	B	L	S	6	0	136	197	155	101	D	L	S	6	1	136	212	153
42	B	M	S	5	10	145	210	158	102	B	M	S	5	10	139	206	162
43	B	L	W	5	9	142	207	158	103	B	D	S	5	7	135	200	156
44	B	L	S	5	6	130	196	151	104	B	D	S	5	7	135	203	154
45	B	L	S	5	8	131	192	149	**105**	B	L	W	5	10	138	212	152
46	B	M	S	5	7	132	190	152	106	B	M	S	5	9	137	194	161
47	B	M	S	5	10	130	199	147	107	D	D	S	5	6	135	199	156
48	B	L	S	5	6	131	196	158	108	B	D	S	5	9	132	202	150
49	B	M	S	5	4	133	191	148	109	B	M	S	5	9	132	204	158
50	B	L	W	5	6	133	202	158	**110**	D	D	S	5	5	132	201	150
51	B	L	S	5	11	137	209	162	111	B	D	S	5	7	133	197	153
52	B	L	S	5	9	137	201	159	112	B	L	S	5	6	129	199	148
53	B	M	S	5	8	136	195	158	113	B	L	S	5	5	131	195	155
54	B	M	S	5	7	134	193	151	114	B	L	S	5	10	137	209	163
55	B	M	R	5	8	128	202	158	**115**	B	L	C	5	7	131	199	148
56	B	M	S	5	5	131	205	155	116	B	M	S	5	6	123	185	149
57	R	M	S	5	7	141	204	154	117	B	D	S	5	2	129	199	143
58	B	L	S	5	8	131	207	156	118	B	M	S	5	7	129	197	152
59	B	M	W	5	11	131	208	151	119	B	L	S	5	5	132	193	145
60	B	L	S	6	0	134	192	153	**120**	B	M	S	5	10	135	205	157
61	B	M	S	5	3	132	197	151	121	B	L	S	5	11	134	206	165
62	B	M	S	5	10	130	203	152	122	B	L	S	5	9	130	202	160
63	B	M	W	5	7	140	204	152	123	B	D	S	5	7	134	212	158
64	D	M	W	5	3	128	184	149	124	B	L	S	5	4	135	206	145
65	B	L	S	5	7	135	196	155	**125**	D	D	S	5	7	128	199	149
66	B	M	S	5	10	129	193	157	126	B	L	S	5	8	128	199	150
67	B	M	S	5	9	133	205	148	127	B	M	W	5	7	136	208	160
68	B	D	S	5	10	140	195	153	128	B	L	W	5	10	142	202	157
69	B	M	S	5	5	127	185	146	129	B	M	S	5	8	140	200	148
70	B	M	S	5	5	140	206	156	**130**	B	L	S	5	7	140	200	152

VI.—Argyll District Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
131	M	L	S	5	6	139	206	152	161	M	L	S	6	0	137	205	160
132	M	L	S	5	10	136	204	155	162	M	L	S	5	6	134	202	144
133	M	M	S	5	5	132	200	157	163	M	D	W	5	10	136	208	159
134	M	L	S	5	2	128	194	142	164	M	M	W	5	5	134	194	150
135	M	L	S	5	2	132	196	152	**165**	M	M	S	6	0	138	193	154
136	M	L	S	5	8	135	207	155	166	M	M	S	5	10	135	206	153
137	M	L	S	5	1	134	195	145	167	M	D	S	5	11	133	197	147
138	M	M	S	5	7	143	197	153	168	M	L	S	5	5	129	196	151
139	M	L	S	5	10	139	211	161	169	M	L	S	5	10	136	196	150
140	M	L	S	5	5	131	191	152	**170**	M	M	S	5	3	135	195	149
141	M	M	S	5	5	136	212	151	171	M	M	S	5	6	136	205	160
142	M	M	S	5	9	148	211	158	172	M	D	S	5	8	132	202	156
143	M	L	S	5	9	131	199	163	173	M	L	W	5	10	134	206	166
144	M	L	W	5	0	132	201	147	174	D	M	S	5	11	138	209	152
145	M	L	S	5	6	132	191	155	**175**	M	L	S	5	5	143	207	158
146	M	L	S	5	7	139	204	159	176	M	M	S	5	5	139	200	150
147	M	L	S	5	7	137	206	148	177	D	D	S	5	5	140	201	157
148	D	L	S	5	8	137	205	145	178	M	L	W	5	9	140	191	151
149	M	L	S	4	10	132	190	146	179	M	M	S	5	10	137	205	145
150	M	M	W	5	2	125	176	138	**180**	R	L	S	5	10	144	202	160
151	D	M	S	5	5	137	195	153	181	M	M	S	5	6	146	208	169
152	M	L	S	5	2	133	200	150	182	M	L	S	5	8	136	207	151
153	M	D	S	5	5	140	201	151	183	M	L	S	5	11	135	203	155
154	M	L	S	5	4	140	197	149	184	M	M	S	5	4	133	193	141
155	M	D	S	5	7	140	202	148	**185**	M	D	S	5	7	132	195	148
156	M	L	S	5	5	135	187	150	186	M	D	S	5	2	131	196	165
157	M	D	S	5	7	135	199	148	187	M	D	S	5	9	150	209	158
158	D	M	S	5	5	134	200	156	188	M	M	S	5	11	141	192	149
159	D	D	S	5	7	145	220	162	189	M	D	S	5	5	144	197	148
160	M	M	S	4	6	137	195	150	**190**	M	L	S	6	0	133	205	153

VII.—Ayr District Asylum.

MALES.									MALES.								
1	M	L	S	5	9	133	189	149	21	M	D	S	5	9	139	199	147
2	M	M	S	5	9	134	192	151	22	M	L	S	5	4	133	197	143
3	M	L	S	5	4	136	192	146	23	M	L	S	5	6	139	189	160
4	M	L	S	5	6	136	194	154	24	M	D	...	5	8	147	197	153
5	D	M	S	5	10	135	198	157	**25**	D	M	S	5	2	143	194	149
6	M	L	S	5	4	134	179	151	26	M	L	S	5	4	137	189	146
7	M	M	S	5	2	133	197	148	27	M	L	S	5	3	136	191	147
8	D	M	W	5	7	146	197	149	28	M	L	S	5	2	143	204	152
9	M	M	S	5	4	139	198	152	29	D	M	S	5	8	139	200	162
10	M	M	S	5	8	137	196	164	**30**	M	L	S	5	5	135	193	146
11	M	L	S	5	1	136	188	148	31	M	M	S	5	7	142	206	148
12	M	L	S	5	5	136	203	157	32	M	L	S	5	8	135	193	151
13	M	L	S	5	6	138	198	154	33	M	M	C	4	10	131	193	149
14	D	L	W	5	2	146	193	139	34	M	M	S	5	7	130	200	146
15	M	L	S	5	7	141	197	153	**35**	D	M	S	5	10	134	189	153
16	D	D	S	5	7	135	206	151	36	M	M	S	5	5	141	202	153
17	M	M	S	5	1	136	197	153	37	M	M	S	5	8	137	194	149
18	F	L	S	5	2	130	196	143	38	D	M	W	5	6	147	204	156
19	M	M	S	5	7	132	207	153	39	M	L	W	5	2	140	189	149
20	M	M	S	5	4	129	200	149	**40**	M	L	S	5	3	135	198	151

VII.—Ayr District Asylum.

MALES.

No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
41	M	M	W	5	6	132	194	152
42	D	D	S	5	8	142	204	157
43	D	L	S	5	4	140	185	148
44	D	L	W	5	4	139	203	144
45	M	L	S	5	4	141	198	160
46	M	L	S	5	6	140	197	149
47	M	L	S	5	10	134	193	152
48	M	M	S	5	6	135	194	154
49	M	L	S	5	6	135	197	151
50	M	M	S	5	9	137	193	153
51	M	L	S	5	5	133	194	153
52	M	M	S	5	6	132	201	151
53	M	L	S	5	8	130	193	144
54	M	M	S	5	4	137	200	155
55	M	M	S	5	9	140	203	149
56	M	M	S	5	7	135	208	159
57	M	D	S	5	10	140	201	153
58	M	L	S	5	6	134	196	147
59	M	L	S	5	3	123	188	143
60	M	M	S	5	8	136	196	149
61	D	M	S	5	9	138	193	151
62	M	L	S	5	6	137	200	149
63	M	L	S	5	5	137	207	146
64	M	L	S	5	0	137	193	153
65	M	L	S	5	8	139	204	152
66	F	L	S	5	6	135	194	146
67	M	D	S	5	8	134	194	146
68	F	M	S	5	4	133	186	149
69	D	L	S	5	2	131	201	154
70	M	M	S	5	5	139	200	153
71	M	M	S	5	9	137	197	151
72	D	D	S	5	7	136	210	160
73	M	L	S	5	6	134	198	156
74	D	L	S	5	7	134	201	159
75	D	M	S	5	8	138	198	149
76	M	D	S	5	8	141	202	153
77	M	L	S	5	9	146	197	156
78	D	D	S	5	3	136	192	152
79	M	L	S	5	4	134	197	146
80	M	L	S	5	9	135	192	148
81	D	D	S	5	4	127	201	156
82	F	L	S	6	0	144	213	164
83	F	L	S	5	9	140	198	149
84	M	M	S	5	9	132	196	157
85	D	L	S	5	9	136	188	146
86	M	L	S	5	5	131	164	146
87	M	L	S	5	7	130	191	152
88	M	L	S	5	3	137	193	147
89	M	L	S	5	8	136	205	152
90	M	L	S	5	2	132	199	146
91	M	M	S	5	5	142	192	155
92	M	L	S	5	7	140	204	154
93	M	L	S	5	8	139	199	148
94	D	M	S	6	0	148	202	154
95	M	D	S	5	2	138	188	158
96	M	M	S	5	8	138	199	147
97	M	D	S	5	3	135	199	155
98	M	D	S	5	1	131	200	153
99	M	L	S	4	9	135	207	152
100	M	D	S	5	6	140	199	159
101	M	L	S	5	5	139	209	162
102	M	L	S	5	7	132	204	160
103	M	M	S	5	5	129	197	155
104	M	D	S	5	5	136	202	154
105	D	M	S	5	6	137	200	159
106	M	M	S	5	2	124	196	148
107	M	D	S	5	7	138	198	147
108	D	D	S	5	1	135	197	146
109	M	L	S	5	4	134	202	156
110	M	D	W	5	6	134	201	149
111	M	L	R	5	2	132	193	158
112	D	L	S	5	2	131	200	161
113	D	L	S	4	1	130	194	158
114	D	L	S	5	5	136	201	152
115	D	M	S	5	2	131	194	148
116	M	L	W	5	5	134	196	154
117	M	M	S	5	5	138	207	152
118	M	L	S	5	5	140	209	160
119	M	M	W	5	5	135	205	151
120	M	L	W	5	6	144	208	150
121	R	L	W	5	7	140	202	155
122	D	M	S	5	5	139	205	154
123	M	L	S	5	5	134	201	154
124	M	L	S	6	0	139	194	148
125	M	D	S	5	3	139	196	148
126	M	L	S	4	11	140	192	151
127	M	L	S	5	5	140	206	154
128	M	M	S	5	4	132	191	149
129	F	L	S	5	7	135	205	156
130	M	D	W	5	6	139	199	149
131	F	L	W	5	6	136	203	156
132	D	D	W	5	2	135	196	152
133	D	M	S	5	5	138	202	148
134	M	L	S	5	2	137	203	158
135	M	D	S	5	5	145	198	156
136	D	D	S	5	4	143	196	156
137	D	M	S	5	3	133	200	153
138	M	L	S	5	0	132	201	146
139	M	L	S	5	5	135	202	157
140	D	M	S	5	3	134	198	149
141	D	M	W	5	5	131	195	148
142	M	M	W	5	5	134	199	151
143	D	M	S	5	8	135	200	149
144	M	D	S	5	4	134	197	154
145	M	M	S	5	5	138	198	157
146	M	M	S	5	2	132	188	154
147	D	D	S	5	8	132	192	148
148	D	M	S	5	7	135	202	155
149	M	D	R	5	8	132	198	157
150	M	M	S	5	9	136	201	160
151	M	L	S	5	11	131	188	144
152	M	M	S	5	5	130	204	154
153	D	L	S	5	8	128	191	151
154	M	L	S	5	8	131	195	141
155	M	M	S	5	5	135	204	163
156	M	D	S	5	8	137	208	153
157	M	M	S	5	10	133	197	148
158	M	L	S	5	5	136	192	159
159	M	L	S	5	9	137	295	155
160	M	L	S	5	11	139	203	156

VII.—Ayr District Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
161	M	L	S	5	4	136	195	149	198	D	M	S	5	5	135	196	151
162	M	D	S	5	4	134	196	148	199	M	D	S	5	6	139	203	160
163	M	M	S	5	9	133	187	145	**200**	M	L	W	5	5	137	205	159
164	M	L	J	5	5	138	202	155	201	M	L	S	5	5	135	192	152
165	M	M	S	5	8	134	208	155	202	M	L	S	5	3	136	189	155
166	M	L	S	5	6	133	195	150	203	M	L	W	5	6	134	202	151
167	M	L	S	5	9	140	202	153	204	M	L	S	5	7	136	203	156
168	M	D	S	5	5	137	195	155	**205**	D	D	S	5	3	130	196	145
169	M	M	S	5	3	142	201	158	206	M	L	S	5	9	136	198	150
170	M	L	S	5	7	144	206	155	207	M	L	W	5	4	139	199	154
171	M	L	S	5	3	130	191	151	208	M	L	S	5	6	136	198	150
172	M	M	S	5	6	135	190	150	209	M	D	S	5	11	136	201	162
173	M	M	S	5	9	136	197	154	**210**	M	L	S	5	7	132	196	149
174	R	D	C	5	11	138	203	159	211	M	L	S	5	9	132	201	165
175	M	L	S	5	5	133	193	149	212	M	L	S	5	7	134	199	155
176	M	M	S	5	3	135	199	153	213	M	M	J	5	5	142	198	154
177	F	L	S	5	6	139	197	152	214	M	D	S	5	9	142	198	150
178	M	L	S	5	6	138	197	150	**215**	D	L	S	5	5	139	196	148
179	M	M	S	5	8	138	200	145	216	N	D	S	5	9	132	200	152
180	M	M	S	5	6	138	198	152	217	M	L	S	5	4	133	189	139
181	M	M	R	5	1	140	199	149	218	M	M	S	5	8	138	197	154
182	M	L	S	5	6	135	194	139	219	M	L	S	5	8	135	210	153
183	D	L	S	5	7	135	200	159	**220**	M	L	J	5	6	130	174	150
184	M	D	S	5	5	134	189	151	221	D	L	S	5	9	137	191	148
185	M	M	S	5	9	144	205	160	222	M	L	W	5	2	132	192	149
186	M	M	S	5	3	140	191	155	223	M	D	S	5	5	136	202	150
187	M	L	S	5	5	134	202	159	224	M	L	S	5	6	138	196	153
188	M	L	S	5	4	132	202	153	**225**	M	M	S	5	3	129	191	152
189	M	L	S	5	1	128	183	158	226	M	L	S	5	8	134	201	153
190	M	M	S	5	9	138	195	150	227	M	L	S	5	8	133	197	160
191	M	D	S	5	4	134	200	153	228	D	M	S	5	7	143	200	152
192	M	L	S	5	4	132	193	149	229	M	L	W	5	6	131	192	148
193	M	L	S	5	8	132	207	147	**230**	M	L	S	4	9	134	200	150
194	F	M	S	6	0	138	198	157	231	M	L	S	5	3	125	194	151
195	M	L	S	5	6	129	197	150	232	M	L	S	5	3	133	196	142
196	M	L	S	5	7	132	208	155	233	M	M	S	4	11	138	189	151
197	M	L	S	5	10	131	192	158									

VIII.—Banff District Asylum.

MALES.									MALES.								
1	...	M	S	5	11	137	195	150	16	D	M	S	5	10	137	187	150
2	M	M	S	5	7	130	186	145	17	...	M	S	5	9	143	200	155
3	D	M	S	5	9	137	194	152	18	D	L	S	5	5	128	198	144
4	M	M	S	5	2	133	202	142	19	M	M	R	5	7	137	195	158
5	D	M	S	5	7	132	196	143	**20**	...	L	S	5	5	130	197	159
6	D	M	S	4	11	143	198	153	21	D	M	C	5	7	136	194	153
7	M	M	S	5	5	132	191	157	22	D	D	S	5	5	136	207	157
8	M	D	S	5	1	141	185	151	23	M	M	S	5	10	136	193	148
9	D	D	S	5	5	138	196	159	24	M	M	S	5	7	138	199	154
10	D	M	S	5	10	132	189	151	**25**	...	M	S	5	5	135	195	159
11	D	M	S	5	8	133	211	163	26	D	M	S	5	9	145	204	155
12	D	M	S	5	4	134	193	156	27	M	M	S	5	9	145	197	158
13	D	M	W	5	8	136	207	159	28	...	M	S	6	1	158	211	162
14	...	M	S	5	7	131	201	156	29	...	M	S	5	8	134	203	155
15	D	D	S	5	2	130	183	147	**30**	M	M	S	5	7	130	195	143

VIII.—Banff District Asylum.

MALES.

No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
31	...	M	S	5	8	145	204	157
32	M	M	S	5	11	139	200	154
33	D	M	S	5	6	131	190	149
34	D	D	S	5	8	133	197	154
35	M	M	S	5	4	134	182	154
36	D	M	S	5	8	131	195	155
37	M	M	S	5	6	136	198	151
38	D	M	S	5	9	132	198	157
39	M	M	S	5	2	116	177	150
40	...	L	S	5	7	136	193	155
41	D	M	S	5	10	132	195	151
42	D	M	S	5	6	134	189	156
43	M	M	S	5	8	137	192	154
44	D	M	S	5	0	132	194	151
45	D	D	S	5	3	153	195	158
46	D	D	S	5	9	143	199	154
47	...	D	S	5	1	133	193	146
48	...	M	S	5	7	132	199	152
49	..	M	S	5	7	125	201	146
50	D	M	S	5	6	139	204	164
51	D	D	S	5	6	135	200	149
52	D	M	S	5	9	135	194	153
53	D	M	S	5	5	134	202	154
54	M	M	S	5	6	143	206	163
55	...	M	S	5	5	131	188	147
56	D	M	C	5	7	135	190	148
57	D	M	S	5	3	136	193	157
58	D	D	S	5	9	136	208	155
59	...	M	S	5	7	130	192	150
60	D	M	S	5	5	143	194	153
61	...	M	S	5	3	137	190	146
62	D	M	S	5	6	132	191	145
63	D	M	S	5	3	128	193	146
64	M	M	S	5	9	144	193	155
65	M	M	S	5	9	136	199	139
66	M	M	S	5	8	140	198	158
67	M	M	S	5	5	129	186	144
68	...	M	S	5	9	143	199	164
69	M	M	S	5	6	141	187	153
70	D	M	S	5	3	133	191	156
71	M	M	S	5	5	134	185	154
72	M	M	S	5	11	144	202	153
73	D	M	S	5	4	147	206	158
74	D	D	S	5	4	140	189	149
75	D	M	S	5	2	141	197	159
76	D	M	S	5	6	135	190	155
77	...	M	S	5	2	139	191	157
78	M	M	S	5	7	140	198	151
79	D	M	S	5	5	137	191	158
80	D	M	S	6	0	142	197	151
81	M	M	S	5	8	131	196	151
82	D	D	S	5	6	130	191	156
83	D	M	S	6	1	144	191	145
84	M	M	S	5	7	140	210	164

IX.—Elgin District Asylum.

MALES.

1	D	M	W	5	5	127	184	141
2	...	L	S	5	6	134	199	151
3	M	M	S	5	7	133	196	149
4	D	D	S	5	8	135	197	155
5	D	D	S	5	5	138	195	161
6	D	M	S	5	7	135	193	155
7	R	M	S	5	7	130	204	163
8	D	M	S	5	6	135	202	152
9	D	D	S	5	3	125	182	145
10	D	M	S	5	6	120	201	144
11	D	D	S	5	7	131	198	150
12	D	D	S	5	4	139	196	156
13	D	M	S	5	5	133	188	150
14	D	M	S	5	0	125	185	145
15	D	M	S	5	5	135	191	145
16	D	M	W	5	0	122	185	142
17	D	M	C	5	7	134	191	154
18	D	M	S	5	7	133	199	155
19	D	M	S	5	4	135	195	154
20	D	M	S	5	7	139	198	154
21	D	M	S	6	0	135	201	161
22	D	M	S	5	3	136	184	154
23	D	M	S	5	1	135	191	153
24	D	D	C	5	4	120	191	145
25	D	M	S	5	4	132	193	155
26	R	M	S	5	5	131	195	150
27	D	M	S	5	7	124	185	153
28	D	D	S	5	7	131	196	154
29	M	M	S	5	2	142	205	158
30	M	M	W	5	8	145	200	157
31	D	M	S	5	8	134	197	150
32	...	M	S	5	7	124	200	143
33	...	M	S	5	11	136	194	153
34	D	M	S	5	11	132	201	163
35	M	M	S	5	8	144	202	151
36	D	D	S	5	8	135	190	147
37	M	M	S	4	11	145	197	155
38	D	M	S	5	5	138	189	148
39	M	M	S	5	2	140	195	148
40	R	M	S	5	10	140	192	155
41	F	L	S	5	1	131	185	138
42	M	M	S	5	7	139	203	154
43	D	D	S	5	7	144	198	153
44	M	M	S	5	8	135	198	159
45	D	M	S	5	4	140	197	147
46	D	M	S	5	6	137	185	154
47	D	M	S	5	7	139	185	151
48	D	M	S	5	9	134	196	157
49	D	D	S	5	6	138	195	152
50	D	D	S	5	2	138	182	153

IX.—Elgin District Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature,		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in	H, mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
51	...	M	S	5	7	139	199	148	62	M	M	C	5	7	133	199	157
52	M	M	S	5	8	139	206	155	63	M	M	S	5	6	130	194	151
53	...	L	S	5	4	129	186	148	64	D	M	S	5	8	129	196	155
54	D	D	S	...		131	188	159	**65**	M	M	S	5	6	140	189	154
55	..	M	S	...		139	196	151	66	D	M	S	5	6	129	193	147
56	...	M	S	5	2	133	192	151	67	D	M	S	4	11	128	193	143
57	D	M	S	5	7	143	202	153	68	D	M	S	5	9	123	190	143
58	M	M	S	5	9	134	204	162	69	M	M	S	4	11	133	194	157
59	...	M	S	5	10	138	195	153	**70**	D	M	S	5	7	127	199	155
60	D	M	S	5	10	136	196	156	71	...	M	S	5	6	131	196	161
61	...	M	S	5	7	137	193	159									

X.—Fife District Asylum.

MALES.									MALES.								
1	M	L	S	5	5	128	189	154	41	M	M	S	5	7	136	193	150
2	R	L	S	5	5	137	198	154	42	M	L	S	5	6	135	193	141
3	M	L	S	5	5	138	194	148	43	M	D	S	5	4	135	195	157
4	M	L	S	5	1	132	191	146	44	M	L	S	5	8	138	201	154
5	D	L	S	5	7	134	202	156	**45**	M	L	S	5	7	136	204	151
6	M	L	S	5	6	134	194	154	46	M	M	S	5	5	141	202	151
7	M	M	R	5	7	138	197	151	47	D	D	S	5	9	130	192	149
8	M	M	S	5	4	133	186	146	48	M	L	S	5	6	138	201	156
9	D	D	S	5	6	133	193	151	49	M	M	S	5	6	138	195	150
10	F	L	S	5	10	132	193	147	**50**	M	L	W	5	10	137	196	146
11	D	L	S	5	4	130	189	146	51	D	D	S	5	2	136	191	152
12	M	M	W	5	6	140	198	154	52	D	M	S	5	3	128	191	144
13	M	L	S	5	7	138	196	151	53	M	L	S	5	8	130	198	152
14	M	L	C	5	6	138	192	151	54	M	L	S	5	8	150	213	172
15	M	...	C	4	3	133	182	143	**55**	M	M	S	5	7	139	190	150
16	M	L	S	5	4	129	187	140	56	M	L	S	5	4	130	199	156
17	F	L	W	5	7	128	197	148	57	D	D	R	5	4	130	188	155
18	M	D	W	5	4	134	200	163	58	M	M	S	5	6	132	190	153
19	M	D	S	5	5	134	202	153	59	D	D	W	5	6	132	194	144
20	M	D	S	5	6	139	203	154	**60**	M	D	S	5	8	137	190	159
21	M	L	S	5	3	138	193	152	61	M	M	C	5	5	135	207	158
22	M	M	S	5	8	132	195	151	62	M	L	S	5	7	135	200	154
23	M	L	W	5	5	133	192	157	63	F	L	S	5	1	109	168	133
24	M	L	S	5	4	138	194	153	64	D	M	S	5	6	129	196	149
25	M	L	S	5	9	138	199	148	**65**	M	M	W	5	3	143	210	167
26	M	M	S	5	9	140	192	154	66	M	L	S	5	9	139	209	153
27	M	M	W	5	4	144	200	156	67	M	L	W	5	6	135	200	151
28	M	L	S	5	5	127	191	150	68	M	L	S	5	3	130	188	153
29	M	M	S	5	11	136	206	160	69	M	L	W	5	8	139	203	149
30	M	D	W	5	6	136	189	147	**70**	D	L	R	5	7	137	200	145
31	M	L	S	5	4	128	189	143	71	M	D	S	5	3	135	190	150
32	D	L	W	5	6	142	208	155	72	M	L	S	5	6	132	200	153
33	M	M	S	5	4	139	198	150	73	M	L	S	5	5	140	202	151
34	M	L	W	5	3	136	185	144	74	M	M	R	5	8	140	183	147
35	M	L	S	5	7	136	191	150	**75**	M	M	S	5	6	133	201	154
36	D	D	S	5	9	138	198	156	76	M	L	S	6	0	137	220	159
37	M	D	S	5	4	138	193	153	77	M	L	S	5	5	133	189	149
38	M	L	S	5	2	136	201	153	78	D	L	S	5	8	138	203	160
39	M	L	W	5	7	141	205	160	79	M	L	W	5	4	127	186	147
40	M	L	W	5	6	136	196	140	**80**	M	M	S	5	3	129	187	142

X.—*Fife District Asylum.*

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
81	M	L	S	5	5	140	196	153	141	M	L	S	5	5	140	202	150
82	M	M	J	5	8	135	198	145	142	M	D	C	5	6	139	200	154
83	D	L	S	5	7	136	197	158	143	F	M	W	5	7	142	198	155
84	M	M	S	5	3	134	189	149	144	M	L	S	5	7	143	195	152
85	M	L	S	5	7	135	203	154	145	M	M	S	5	9	141	198	155
86	M	D	S	5	6	136	203	155	146	D	D	S	5	11	136	195	147
87	M	L	S	5	4	135	195	154	147	M	L	S	5	7	137	198	159
88	M	L	W	5	6	132	189	144	148	M	L	S	5	5	136	196	151
89	D	L	W	5	10	131	189	148	149	M	M	S	5	9	136	197	152
90	M	L	S	5	5	138	198	150	150	M	D	S	5	4	140	212	156
91	M	M	S	5	7	140	195	147	151	M	L	S	5	7	135	203	143
92	M	L	S	5	7	135	206	152	152	M	M	S	5	5	134	195	158
93	M	L	W	5	5	135	194	160	153	D	D	S	5	8	133	191	149
94	M	M	S	5	8	136	197	152	154	M	L	S	5	8	135	194	156
95	M	L	S	5	10	139	207	158	155	M	M	S	5	6	136	192	151
96	M	D	S	5	3	134	186	147	156	M	L	S	5	9	137	198	149
97	D	L	S	5	5	134	193	152	157	D	M	W	5	7	136	192	152
98	D	L	S	5	5	133	188	145	158	M	D	S	5	6	131	189	148
99	M	L	S	5	7	136	204	159	159	M	L	S	5	4	132	197	148
100	M	M	S	5	8	146	201	155	160	D	M	S	5	4	134	194	151
101	M	L	S	5	2	140	185	140	161	M	L	S	5	6	132	198	150
102	M	M	S	5	4	134	189	145	162	M	L	S	5	6	137	196	152
103	M	L	S	5	4	135	201	158	163	M	M	S	5	7	135	209	152
104	M	M	S	5	8	137	199	157	164	M	M	W	5	8	134	201	147
105	M	L	S	5	4	136	197	153	165	M	L	S	5	3	139	205	163
106	M	L	S	5	4	135	191	143	166	M	M	S	5	8	125	181	136
107	M	M	S	5	7	140	203	155	167	M	L	W	5	8	139	189	146
108	F	L	S	5	5	138	189	151	168	M	L	S	5	6	134	203	151
109	M	L	S	5	6	129	197	155	169	M	L	S	5	7	136	196	154
110	M	L	W	5	4	134	194	150	170	M	L	W	5	5	135	189	160
111	M	L	S	5	4	135	207	155	171	M	L	S	5	0	133	188	144
112	M	M	S	5	5	127	184	147	172	M	M	S	5	1	130	188	147
113	M	M	S	5	11	132	192	154	173	M	L	S	5	7	138	198	148
114	M	D	S	5	7	132	192	143	174	M	L	S	5	4	127	187	154
115	M	L	R	5	7	135	194	149	175	M	L	C	5	5	138	194	147
116	M	M	S	5	8	134	197	149	176	F	L	S	5	6	137	204	158
117	M	M	S	5	6	136	189	150	177	M	M	S	5	5	135	200	154
118	M	L	S	5	4	138	189	152	178	M	L	S	5	7	140	192	150
119	M	D	S	5	6	138	206	155	179	M	L	S	5	7	137	202	155
120	F	L	S	5	8	135	193	144	180	D	D	S	5	7	140	197	151
121	M	D	S	5	11	132	191	156	181	M	M	W	5	7	141	202	149
122	M	L	S	5	6	132	196	153	182	D	D	W	5	0	139	195	153
123	M	M	S	5	7	135	194	157	183	M	M	R	5	1	133	181	145
124	M	L	W	5	6	132	189	155	184	M	D	W	5	3	140	192	151
125	M	M	S	5	9	136	196	150	185	M	M	R	5	7	136	191	155
126	M	L	S	5	6	133	198	155	186	D	L	S	5	5	138	189	154
127	D	M	S	5	6	132	206	162	187	M	L	W	5	5	138	203	153
128	M	M	S	5	7	132	187	158	188	M	M	S	5	6	139	195	143
129	F	M	S	5	5	133	198	153	189	M	D	S	5	3	149	194	150
130	M	L	S	5	4	131	192	156	190	M	L	S	5	3	146	200	156
131	M	L	S	5	4	135	202	150	191	M	M	S	5	7	137	202	148
132	F	L	S	5	7	136	203	161	192	M	L	W	5	8	135	198	150
133	M	L	S	5	0	129	189	150	193	M	L	S	5	8	140	192	144
134	M	L	S	5	6	139	202	149	194	M	L	W	6	0	138	204	147
135	M	D	S	5	5	138	187	150	195	M	L	W	4	11	136	203	149
136	M	L	S	5	7	136	196	152	196	M	M	S	5	7	136	191	152
137	M	L	S	5	5	135	202	158	197	M	D	S	5	7	133	197	149
138	D	D	R	5	0	117	182	140	198	M	D	S	5	6	134	193	154
139	M	L	S	5	2	128	195	153	199	M	M	S	5	6	135	197	161
140	D	D	W	5	6	126	181	148	200	D	D	S	5	8	134	190	150

X.—Fife District Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
201	D	L	S	5	6	139	192	159	208	M	L	S	5	9	135	195	153
202	M	L	S	5	11	142	209	160	209	M	M	S	5	5	140	209	152
203	M	D	S	5	2	131	182	145	**210**	M	L	S	5	5	141	201	151
204	M	L	S	5	6	134	199	158	211	M	M	S	5	3	138	195	143
205	M	L	S	5	1	133	192	148	212	M	L	S	5	5	135	193	155
206	M	L	R	5	8	139	197	157	213	D	M	S	5	2	127	194	151
207	M	L	S	5	8	135	196	146	214	D	D	S	5	7	132	186	148

XI.—Glasgow District Asylum (Gartloch).

MALES.									MALES.								
1	M	L	S	5	7	136	205	152	46	M	L	S	5	3	136	197	147
2	M	L	S	5	7	130	190	150	47	M	L	S	5	4	130	185	148
3	M	D	S	5	6	131	193	148	48	M	L	W	5	9	136	195	150
4	D	M	S	5	6	141	202	149	49	L	W	...	5	5	135	190	147
5	M	M	S	5	6	136	193	148	**50**	M	M	S	5	7	142	210	154
6	M	L	S	5	5	137	202	155	51	M	L	S	5	6	133	194	144
7	M	L	S	5	10	133	199	149	52	M	D	S	5	2	139	202	153
8	M	L	S	5	6	146	212	153	53	M	D	S	5	6	135	186	154
9	M	M	S	5	6	130	184	141	54	M	M	S	5	4	132	194	147
10	M	L	W	5	7	132	198	146	**55**	M	L	S	5	2	130	185	146
11	D	D	S	5	5	130	200	156	56	M	M	S	5	8	132	195	149
12	D	L	S	5	3	132	201	157	57	M	M	S	5	7	145	199	150
13	M	L	S	5	2	133	200	158	58	M	L	S	5	7	142	187	150
14	F	L	S	5	7	132	199	153	59	M	L	S	5	8	138	203	159
15	D	D	C	5	8	136	194	151	**60**	M	D	S	5	3	138	203	154
16	M	D	S	5	6	138	199	153	61	M	L	S	5	8	146	206	157
17	M	L	S	5	3	134	192	152	62	D	D	S	5	5	142	192	142
18	D	M	S	5	3	137	194	156	63	M	D	S	5	8	145	205	157
19	D	D	S	5	7	129	193	153	64	M	D	S	5	9	142	193	144
20	D	M	S	5	10	127	194	149	**65**	M	L	S	5	6	137	187	144
21	F	L	S	5	2	134	192	147	66	M	L	S	5	2	134	186	146
22	D	M	W	5	8	130	193	149	67	M	L	S	5	5	135	201	150
23	M	M	S	5	9	141	196	149	68	M	M	S	5	4	142	202	154
24	D	D	S	5	9	141	196	156	69	M	M	S	5	6	141	192	153
25	M	L	S	5	3	138	203	147	**70**	M	M	S	5	6	142	195	150
26	M	L	S	5	1	136	200	154	71	M	D	S	5	2	127	193	132
27	D	L	S	5	4	135	194	150	72	M	D	S	5	3	132	194	146
28	D	L	S	5	7	133	194	148	73	M	D	S	4	7	138	197	158
29	M	L	S	5	2	127	182	134	74	M	D	S	5	9	141	201	149
30	M	L	S	5	7	137	199	149	**75**	M	L	S	5	3	141	192	156
31	M	L	...	5	2	131	200	152	76	M	M	W	5	7	130	199	156
32	M	L	W	5	3	137	195	149	77	M	M	S	5	7	138	205	149
33	F	L	S	5	3	128	191	149	78	M	L	S	5	8	134	194	151
34	M	M	S	5	10	130	189	153	79	D	L	C	5	10	141	212	169
35	F	L	S	5	6	141	200	150	**80**	M	L	W	5	6	148	194	152
36	M	L	S	5	7	142	199	148	81	D	D	W	5	5	134	189	143
37	M	M	S	5	7	135	187	150	82	M	M	S	5	7	135	195	149
38	M	M	S	5	5	147	199	153	83	M	M	W	5	4	141	198	152
39	M	D	S	5	6	143	192	146	84	M	L	S	6	0	138	205	156
40	M	L	W	4	10	141	199	150	**85**	M	D	S	5	6	134	200	150
41	D	M	S	5	3	137	199	144	86	M	M	R	5	6	140	202	153
42	M	M	S	5	6	141	197	150	87	M	M	S	5	9	139	198	153
43	M	L	S	5	1	141	201	162	88	D	M	S	5	1	143	195	153
44	M	M	S	5	7	130	194	147	89	M	M	S	5	8	140	200	148
45	F	M	S	5	4	137	204	163	**90**	M	L	S	5	6	133	197	138

XI.—Glasgow District Asylum (Gartloch).

MALES.									MALES.								
No	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
91	M	D	S	5	2	131	186	150	151	M	D	R	5	4	140	199	158
92	M	D	S	5	3	134	192	149	152	M	M	W	5	2	138	196	149
93	M	M	S	5	7	137	194	153	153	M	M	S	5	2	132	186	143
94	M	D	W	5	3	134	189	148	154	M	L	S	5	4	135	195	152
95	M	L	S	5	8	127	201	152	**155**	D	D	S	5	5	137	182	144
96	M	M	S	5	10	137	199	151	156	M	L	S	5	1	142	196	160
97	M	D	W	5	9	135	203	155	157	D	D	W	5	5	143	199	149
98	M	M	S	5	6	134	193	152	158	M	D	W	5	3	137	192	148
99	M	L	W	5	2	132	196	151	159	R	M	R	5	9	142	203	154
100	M	L	W	5	2	132	192	151	**160**	M	L	R	5	6	135	192	157
101	D	M	S	5	9	137	199	147	161	M	M	S	5	8	142	202	150
102	M	M	S	5	5	131	189	152	162	M	M	S	5	5	134	195	150
103	M	L	S	5	7	132	198	151	163	M	L	W	5	9	131	181	144
104	D	L	S	5	1	131	188	153	164	M	M	S	5	6	136	196	152
105	D	L	S	5	6	130	186	150	**165**	M	D	S	5	9	136	194	156
106	M	L	S	5	8	133	203	156	166	M	L	C	5	7	138	196	157
107	M	M	S	5	2	128	181	140	167	M	L	S	5	9	133	199	152
108	M	L	S	5	7	136	190	153	168	D	D	S	4	11	132	195	155
109	M	M	S	5	6	129	200	159	169	M	L	S	5	1	132	190	145
110	M	D	S	5	3	134	203	156	**170**	M	M	S	5	4	135	193	151
111	M	L	W	5	3	139	207	152	171	M	L	S	5	5	129	189	151
112	D	L	S	5	9	139	210	158	172	D	D	S	6	0	133	194	152
113	M	L	S	5	6	140	190	150	173	M	D	R	5	2	128	185	145
114	M	L	S	5	8	139	207	146	174	M	D	W	5	7	144	202	152
115	M	L	S	5	8	127	194	152	**175**	M	D	S	5	10	140	204	154
116	D	D	S	5	2	135	195	145	176	D	L	S	5	8	136	194	145
117	D	L	C	5	6	133	190	141	177	F	L	S	5	6	134	180	144
118	D	L	S	5	8	129	200	151	178	M	L	S	5	2	134	200	150
119	M	M	S	5	7	133	190	148	179	M	L	S	5	1	128	189	150
120	M	L	S	5	3	129	187	134	**180**	M	L	R	5	7	134	203	149
121	M	L	S	4	10	121	179	134	181	M	L	S	5	5	138	197	154
122	M	L	W	5	6	130	200	149	182	M	L	S	5	6	124	195	145
123	M	M	S	5	6	133	211	159	183	D	D	S	5	7	134	194	148
124	M	M	S	5	2	133	188	149	184	D	D	R	5	2	128	180	145
125	D	L	S	5	8	135	196	152	**185**	M	D	S	5	4	118	185	146
126	M	M	S	5	5	129	195	147	186	M	L	S	5	4	136	193	152
127	D	D	S	5	5	128	190	149	187	D	L	S	5	6	135	205	155
128	M	D	S	5	6	129	194	153	188	M	L	W	5	3	133	199	148
129	M	D	S	5	4	136	201	153	189	M	L	S	5	4	140	194	153
130	M	L	S	5	2	135	203	159	**190**	M	D	S	5	2	132	188	152
131	F	L	S	5	5	134	194	146	191	M	M	W	5	4	132	190	144
132	F	M	W	5	9	141	199	147	192	M	D	S	5	4	128	193	154
133	F	L	S	5	1	152	202	163	193	M	L	S	5	5	134	186	146
134	M	L	S	5	6	139	204	158	194	M	L	S	5	6	136	183	146
135	D	M	W	5	4	134	192	149	**195**	M	L	S	4	9	124	177	138
136	F	L	S	5	8	137	198	151	196	M	L	W	5	0	128	199	159
137	M	L	S	5	5	135	200	159	197	M	D	S	5	6	136	195	158
138	M	L	S	5	3	136	192	150	198	M	L	S	5	5	134	188	150
139	D	D	S	5	6	136	184	149	199	M	L	S	5	9	138	198	156
140	M	M	S	5	1	127	185	139	**200**	D	D	W	5	2	129	180	137
141	M	M	S	5	7	134	195	142	201	M	L	S	5	2	128	196	145
142	D	D	S	4	7	136	193	151	202	M	L	W	5	3	128	198	143
143	F	L	S	5	6	135	192	147	203	M	L	S	5	8	137	194	158
144	M	M	S	5	2	133	186	148	204	M	L	S	5	10	139	195	150
145	M	M	W	5	8	134	193	148	**205**	M	L	S	5	3	140	195	153
146	M	M	S	5	1	144	196	150	206	M	D	J	5	4	140	206	151
147	M	L	S	5	5	133	187	149	207	D	M	S	5	8	136	198	156
148	F	M	S	5	4	133	191	149	208	M	L	S	5	5	132	198	152
149	M	L	S	5	2	127	184	138	209	M	L	S	5	3	143	200	162
150	M	L	S	5	6	133	200	153	**210**	M	D	S	5	2	128	193	150

XI.—Glasgow District Asylum (Gartloch).

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
211	D	D	S	5	4	131	199	145	254	M	M	S	5	8	143	208	169
212	M	L	S	5	9	136	205	145	**255**	M	L	W	6	0	140	204	156
213	D	L	S	5	3	134	210	157	256	M	D	S	5	9	142	203	158
214	M	L	S	5	3	134	199	152	257	M	L	S	5	3	140	196	154
215	D	D	S	5	8	137	202	157	258	M	L	S	5	4	135	194	152
216	M	L	S	5	1	136	194	151	259	M	L	S	5	4	135	194	149
217	M	L	S	4	11	121	164	140	**260**	M	D	S	5	5	131	184	150
218	M	M	S	5	8	125	190	148	261	M	M	S	5	6	134	193	141
219	M	L	W	5	3	137	189	143	262	M	L	S	5	9	133	195	151
220	D	D	S	5	2	142	204	151	263	M	L	S	5	4	137	201	152
221	D	D	S	5	4	122	195	144	264	M	L	S	5	7	137	201	156
222	D	D	S	5	7	128	195	150	**265**	M	L	S	5	0	138	198	153
223	M	D	S	5	7	134	196	144	266	M	L	S	...		133	191	143
224	M	L	W	5	6	134	188	147	267	M	L	S	5	6	131	194	149
225	M	L	S	5	7	133	189	150	268	M	L	S	5	9	138	200	153
226	M	D	S	5	8	124	181	152	269	M	D	S	5	4	140	190	148
227	M	D	S	5	4	131	190	146	**270**	F	L	R	5	9	140	197	148
228	M	M	S	5	8	136	195	152	271	M	M	S	5	4	134	197	151
229	M	L	S	5	10	139	202	159	272	D	D	S	5	3	118	177	137
230	D	D	S	5	7	136	205	157	273	F	L	S	5	7	134	197	148
231	M	M	S	5	5	141	197	154	274	M	M	S	5	4	133	189	146
232	M	L	S	5	9	143	202	157	**275**	M	M	S	5	7	129	207	147
233	M	D	S	5	11	136	206	151	276	M	L	S	5	5	133	188	158
234	M	L	S	5	3	128	190	142	277	M	D	S	5	5	134	196	152
235	M	L	S	5	7	139	202	157	278	M	M	S	5	0	134	189	148
236	M	M	S	5	3	139	191	146	279	M	D	S	5	7	133	199	161
237	F	L	S	5	4	139	185	145	**280**	D	D	S	5	7	141	202	152
238	M	L	S	5	3	131	183	149	281	M	D	S	5	1	137	193	146
239	M	L	W	5	11	134	195	157	282	M	L	S	5	7	132	198	146
240	M	L	S	5	9	135	192	146	283	M	M	S	5	2	133	186	152
241	M	D	S	5	8	131	198	145	284	M	D	R	5	3	133	200	160
242	M	L	S	5	4	142	197	157	**285**	M	L	W	5	8	131	204	151
243	M	L	S	5	2	140	192	153	286	M	D	S	5	5	131	205	156
244	D	M	S	5	8	133	200	150	287	D	D	S	5	7	133	194	161
245	M	L	S	5	9	134	195	149	288	M	L	W	5	3	134	194	150
246	M	D	S	5	5	134	189	150	289	M	L	S	5	2	132	189	142
247	D	L	S	5	7	137	196	152	**290**	D	M	S	5	9	138	203	162
248	M	D	S	5	6	140	199	151	291	M	L	S	5	6	134	195	141
249	M	M	S	5	4	136	188	148	292	F	L	W	5	5	138	192	152
250	M	D	S	4	2	137	187	145	293	M	D	S	5	6	141	196	145
251	M	D	W	5	4	131	192	142	294	M	M	S	5	6	138	203	154
252	M	L	W	5	2	135	198	154	**295**	M	L	S	5	6	133	191	150
253	M	L	S	5	5	138	191	151									

XII.—Glasgow District Asylum (Lenzie).

MALES.									MALES.								
1	M	L	R	5	8	131	197	140	11	M	M	S	5	4	137	205	161
2	M	L	S	5	4	137	195	149	12	M	D	S	5	9	144	209	156
3	D	D	W	5	8	136	201	156	13	M	L	W	5	6	134	197	149
4	M	L	R	5	6	132	190	154	14	M	M	S	5	8	127	199	157
5	M	M	S	5	3	134	187	147	**15**	M	L	S	5	7	130	190	149
6	M	M	S	6	0	134	206	159	16	M	L	S	5	3	137	201	149
7	F	L	S	5	5	138	197	146	17	M	L	S	5	9	137	196	147
8	R	D	S	5	10	137	194	154	18	M	L	S	5	7	136	199	145
9	M	L	S	5	1	123	179	132	19	M	L	S	5	7	141	209	159
10	M	D	S	5	5	134	189	148	**20**	M	M	S	5	9	136	202	154

XII.—Glasgow District Asylum (Lenzie).

MALES.									MALES.								
No	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
21	M	L	S	5	6	130	202	142	81	M	L	S	5	8	140	191	148
22	M	L	S	5	3	135	200	149	82	D	M	S	5	3	141	194	156
23	M	L	S	5	4	135	193	152	83	M	L	W	5	5	134	188	159
24	D	D	S	5	3	135	209	154	84	M	L	W	5	3	128	191	137
25	M	M	S	5	5	136	202	153	**85**	D	M	S	4	8	129	178	147
26	M	L	S	5	5	135	197	145	86	M	D	S	5	3	134	192	147
27	M	L	J	5	7	132	196	153	87	D	D	W	5	2	122	189	134
28	M	L	S	5	6	132	196	149	88	D	L	S	5	3	136	200	151
29	M	L	S	5	3	133	193	151	89	D	D	W	5	5	136	189	144
30	F	L	S	5	8	133	187	143	**90**	D	L	S	5	3	130	188	148
31	D	D	W	5	6	140	197	154	91	D	L	S	5	2	124	187	140
32	M	L	S	5	6	139	199	156	92	M	M	S	5	4	139	185	155
33	M	D	S	5	6	135	186	146	93	D	M	W	5	4	135	188	143
34	F	D	S	5	5	144	199	154	94	M	L	S	4	10	136	189	145
35	M	L	S	5	6	133	190	148	**95**	M	L	S	5	3	137	202	148
36	M	L	S	5	3	127	189	147	96	D	L	W	5	1	142	202	151
37	M	L	S	5	7	133	192	147	97	M	D	S	4	9	122	177	129
38	F	L	S	5	4	133	194	154	98	M	M	S	5	2	135	200	149
39	M	D	R	5	8	144	202	154	99	M	D	W	5	0	153	194	161
40	D	L	S	5	6	135	185	147	**100**	M	L	R	5	1	130	186	144
41	D	L	S	5	6	132	191	149	101	M	D	W	5	7	134	199	146
42	M	L	S	5	9	136	199	154	102	M	L	S	5	8	134	199	149
43	M	D	S	5	5	134	195	153	103	M	M	S	5	7	140	208	159
44	M	L	S	5	5	135	191	147	104	M	M	S	5	6	135	190	150
45	D	D	W	5	4	133	194	146	**105**	M	L	S	5	5	136	209	155
46	M	L	S	5	9	137	205	158	106	M	L	W	5	11	141	198	152
47	M	L	R	5	3	139	193	151	107	M	M	S	5	8	132	197	155
48	M	L	S	5	3	127	190	147	108	M	L	R	5	6	125	188	142
49	M	M	S	5	4	128	189	150	109	M	M	R	5	5	136	195	160
50	D	D	S	5	9	145	196	154	**110**	M	M	W	5	11	135	196	148
51	M	L	S	5	5	135	189	144	111	M	M	R	5	8	131	196	145
52	M	L	W	5	4	139	199	142	112	M	D	S	5	6	129	190	144
53	D	L	W	5	7	141	205	153	113	M	D	S	5	7	134	192	146
54	M	M	W	5	7	127	187	142	114	D	M	S	5	6	132	200	151
55	M	D	W	5	8	147	194	156	**115**	M	M	W	5	7	134	200	143
56	M	D	S	5	4	134	189	145	116	M	L	S	5	7	137	192	148
57	M	D	S	5	4	140	194	152	117	M	D	S	4	10	131	192	150
58	M	L	S	5	4	127	189	148	118	D	D	S	5	3	134	187	152
59	M	L	S	5	2	131	190	145	119	M	L	S	5	3	140	191	150
60	D	D	S	5	5	125	195	145	**120**	D	D	S	5	10	124	186	141
61	M	L	S	5	1	131	187	142	121	M	L	S	5	11	131	194	153
62	M	L	R	5	9	137	190	148	122	D	M	S	5	11	137	197	154
63	M	L	S	5	3	146	190	148	123	M	D	S	5	6	133	201	158
64	D	L	S	5	10	143	199	153	124	D	L	S	5	7	133	204	151
65	D	D	S	5	5	132	184	146	**125**	M	D	S	5	2	128	185	145
66	M	D	S	5	6	131	184	144	126	D	L	S	5	7	138	203	154
67	M	D	W	4	8	139	205	163	127	M	D	S	5	3	138	207	158
68	D	D	W	5	6	135	194	144	128	M	L	S	5	5	144	202	152
69	M	M	S	5	2	128	190	143	129	M	D	S	5	4	140	197	150
70	M	M	S	5	4	131	186	156	**130**	M	M	W	5	5	134	192	149
71	M	D	S	5	3	133	195	158	131	M	D	S	5	4	138	197	154
72	M	L	S	5	5	140	196	147	132	M	M	W	5	8	135	190	146
73	F	L	S	5	3	138	194	145	133	M	M	S	5	5	143	182	158
74	M	M	S	5	3	133	192	159	134	M	M	S	5	6	133	190	146
75	D	D	S	4	9	130	184	154	**135**	D	D	R	5	1	125	181	139
76	M	D	W	5	6	140	199	153	136	M	L	W	5	2	135	187	141
77	D	D	S	5	6	134	193	145	137	M	D	R	5	7	133	187	147
78	D	D	W	5	5	138	202	158	138	M	M	S	5	1	130	190	147
79	M	L	S	5	5	126	174	141	139	M	D	W	5	7	141	202	146
80	M	M	S	5	4	143	189	146	**140**	M	D	S	5	9	139	176	151

XII.—Glasgow District Asylum (Lenzie).

MALES.

No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
141	D	D	S	5	7	138	196	151
142	F	L	S	5	6	136	203	152
143	D	D	W	5	4	140	188	147
144	M	L	S	5	9	138	190	146
145	M	L	S	5	5	132	198	149
146	M	L	R	5	7	135	192	155
147	R	D	S	5	4	135	202	155
148	M	L	S	5	7	135	208	166
149	M	L	S	5	8	133	192	149
150	D	D	S	5	5	139	190	160
151	M	M	S	5	9	136	185	156
152	M	L	S	5	9	135	193	143
153	M	L	S	5	5	130	193	151
154	M	M	S	5	8	140	200	154
155	M	M	S	5	6	140	198	155
156	M	D	W	5	5	134	192	152
157	M	D	S	5	2	139	203	153
158	D	M	R	5	0	132	188	147
159	M	L	S	4	9	134	193	143
160	D	D	S	5	0	132	203	152
161	M	L	S	5	5	141	196	152
162	M	M	S	6	3	160	218	154
163	D	D	W	5	4	139	197	149
164	M	D	S	5	8	131	199	155
165	M	M	W	5	3	134	191	140
166	M	M	W	5	5	139	201	154
167	M	L	W	5	1	118	180	135
168	D	L	W	5	7	130	200	159
169	M	L	S	5	3	140	198	158
170	M	L	S	5	5	142	193	150
171	M	M	S	5	4	136	193	140
172	D	D	W	5	6	135	187	141
173	M	M	S	5	7	139	203	155
174	M	L	S	5	7	135	198	149
175	M	L	S	5	9	135	201	149
176	M	L	S	5	5	134	195	150
177	M	L	S	5	11	145	203	158
178	D	D	S	5	3	142	199	153
179	M	L	S	5	8	136	200	143
180	D	D	S	5	5	133	185	152
181	D	M	W	5	8	135	194	147
182	M	L	S	5	7	147	202	160
183	M	L	W	5	4	144	182	154
184	M	L	S	5	2	139	191	151
185	M	D	S	4	10	132	187	150
186	D	D	S	5	4	134	187	148
187	D	D	W	5	6	133	200	156
188	M	D	S	5	8	133	203	158
189	M	L	S	5	8	135	198	155
190	M	L	S	5	5	134	193	147
191	M	M	S	5	8	135	194	151
192	D	D	S	5	6	142	196	160
193	D	D	R	5	7	[illegible]	196	145
194	D	M	S	5	4	134	189	154
195	M	L	S	5	4	129	193	155
196	M	M	S	5	6	131	189	150
197	D	D	W	5	7	142	191	147
198	M	L	W	5	5	142	189	149
199	M	M	S	5	10	139	192	152
200	M	L	S	5	4	139	176	142

MALES.

No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
201	M	M	S	5	3	140	204	163
202	M	M	S	5	6	132	187	150
203	M	L	W	5	6	134	208	153
204	M	L	W	5	3	136	199	151
205	D	D	S	5	7	139	195	145
206	M	M	S	5	8	149	189	152
207	D	D	W	4	11	136	193	152
208	D	D	S	4	10	137	185	160
209	M	L	S	6	0	133	202	149
210	D	M	S	5	5	136	195	153
211	M	M	S	5	6	142	202	151
212	M	D	S	5	5	135	185	149
213	M	M	W	5	4	135	190	147
214	M	M	W	5	4	139	192	144
215	M	D	S	5	5	135	190	151
216	M	L	S	4	11	138	203	151
217	M	M	S	5	7	131	189	148
218	M	D	S	5	0	137	196	148
219	M	L	S	4	7	132	192	142
220	M	L	S	4	10	139	188	158
221	M	M	S	5	2	136	185	145
222	M	M	S	5	8	143	205	162
223	D	L	S	5	2	135	192	157
224	M	D	S	5	6	135	190	151
225	D	D	S	4	11	133	192	148
226	D	L	S	5	7	135	193	146
227	M	D	W	5	6	137	200	151
228	F	D	S	5	1	134	185	146
229	D	D	S	5	8	143	191	155
230	M	L	S	5	2	131	190	160
231	D	D	S	5	5	144	187	154
232	D	L	W	5	0	132	194	151
233	D	L	W	5	5	143	202	158
234	M	M	W	5	6	140	200	147
235	M	M	W	5	5	135	192	154
236	D	L	S	5	5	137	204	148
237	D	L	S	5	1	133	195	144
238	D	D	S	5	4	135	201	148
239	D	D	S	5	3	132	199	146
240	M	L	S	5	9	146	201	150
241	D	L	S	5	4	140	196	152
242	M	M	S	5	6	129	189	147
243	M	L	S	4	10	135	191	147
244	M	M	S	5	6	135	191	164
245	D	D	S	5	9	137	190	147
246	D	L	S	5	8	133	187	147
247	D	D	S	5	6	136	194	151
248	D	D	W	5	7	134	190	141
249	M	L	W	5	5	136	200	148
250	D	D	W	5	1	134	181	144
251	M	L	W	5	5	130	190	149
252	M	L	W	5	3	138	189	156
253	M	D	W	5	6	134	184	145
254	D	L	W	5	3	123	191	142
255	R	M	S	4	10	133	187	135
256	M	M	S	5	1	136	200	146
257	D	L	S	5	0	134	192	140
258	D	L	W	5	6	136	196	146
259	F	L	S	5	6	136	188	148
260	F	M	S	5	5	128	185	142

XII.—Glasgow District Asylum (Lenzie).

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
261	D	D	S	5	6	131	196	151	317	M	D	S	5	2	130	203	152
262	M	M	S	5	5	135	201	150	318	D	L	W	5	4	130	198	147
263	M	D	S	5	7	143	207	161	319	M	L	W	5	7	132	190	148
264	M	M	S	5	4	145	204	158	**320**	D	D	W	5	6	136	200	150
265	D	D	S	5	10	139	192	148	321	D	D	C	5	2	132	186	143
266	M	L	W	5	6	137	191	152	322	M	D	S	5	5	133	196	148
267	M	L	S	5	7	142	205	152	323	M	D	R	5	3	132	184	140
268	M	L	W	5	4	137	193	157	324	D	D	S	5	8	133	198	159
269	M	M	S	5	5	135	193	155	**325**	M	M	S	4	10	133	190	153
270	D	D	S	5	6	134	188	143	326	M	L	S	5	6	145	201	156
271	M	M	R	5	8	135	188	142	327	D	D	C	5	0	135	193	150
272	D	L	S	5	1	142	199	154	328	M	L	W	5	4	138	188	145
273	M	L	S	5	7	125	195	150	329	D	D	W	5	5	129	195	152
274	D	L	S	5	6	148	202	159	**330**	M	L	S	5	5	129	197	142
275	M	M	S	5	11	142	197	151	331	M	L	S	5	6	133	192	142
276	M	M	W	5	6	153	195	156	332	M	L	W	5	3	133	188	144
277	D	L	S	5	8	134	197	148	333	D	M	S	5	4	132	187	137
278	M	D	S	5	5	137	193	149	334	M	D	S	5	6	133	190	144
279	D	D	S	5	8	143	217	158	**335**	M	L	S	5	7	137	194	148
280	D	M	S	5	0	131	176	149	336	M	D	S	5	5	138	193	146
281	D	M	S	5	6	131	182	143	337	M	L	S	5	1	134	196	153
282	M	L	S	5	4	121	195	145	338	D	D	W	4	10	145	185	145
283	M	D	S	5	1	131	194	153	339	M	L	W	5	4	126	189	151
284	M	D	S	5	5	135	183	153	**340**	D	L	S	5	5	143	197	152
285	M	L	S	5	2	135	193	154	341	M	L	S	5	1	136	183	147
286	M	L	S	5	3	138	189	156	342	M	D	S	5	1	130	187	148
287	M	M	S	5	2	133	199	147	343	D	L	C	5	1	125	184	150
288	M	D	S	5	4	132	186	143	344	M	D	S	5	1	139	182	158
289	R	L	S	5	6	137	186	146	**345**	M	L	S	5	5	139	191	151
290	M	D	S	5	10	142	201	153	346	D	D	S	5	4	142	200	147
291	M	M	S	4	11	140	182	143	347	M	D	S	5	11	137	207	154
292	M	L	S	4	10	137	193	155	348	M	M	S	5	5	132	195	147
293	M	L	R	5	2	137	185	139	349	M	M	R	5	4	133	197	143
294	M	L	S	5	8	137	193	152	**350**	M	M	W	5	3	133	196	150
295	M	L	S	5	4	131	194	158	351	M	L	W	5	7	136	196	155
296	D	D	W	5	3	133	189	147	352	M	M	W	5	3	139	193	160
297	M	L	S	5	3	135	191	146	353	D	M	S	5	5	138	201	156
298	M	M	S	5	7	136	182	152	354	M	L	S	5	7	141	196	148
299	M	M	S	5	7	133	185	146	**355**	M	L	S	5	5	137	194	151
300	M	M	S	5	5	134	196	151	356	D	D	W	5	6	138	196	155
301	M	L	S	4	11	136	195	149	357	M	L	W	5	4	138	195	151
302	M	D	S	5	7	137	191	147	358	M	M	S	5	6	135	190	146
303	F	M	S	5	1	139	196	151	359	M	D	S	5	6	139	198	146
304	M	D	S	5	8	139	190	152	**360**	D	D	S	5	5	143	198	155
305	M	L	W	5	3	134	186	155	361	D	L	S	5	5	141	201	149
306	M	L	S	5	2	128	189	148	362	M	M	S	5	11	136	198	148
307	D	D	S	4	10	134	188	157	363	D	D	W	5	7	141	204	158
308	M	L	S	5	11	138	200	156	364	D	M	W	5	6	139	190	150
309	D	D	S	5	2	135	195	153	**365**	M	D	S	6	0	139	197	152
310	M	L	S	5	4	131	200	160	366	M	L	S	5	6	135	200	150
311	M	L	S	5	4	132	193	146	367	M	M	S	5	2	130	188	143
312	M	D	S	5	5	140	194	154	368	D	D	S	5	2	130	191	149
313	M	L	S	5	0	129	184	148	369	M	L	S	4	10	140	200	159
314	D	D	S	5	0	137	194	145	**370**	D	L	S	5	5	140	197	152
315	D	L	S	5	0	133	183	150	371	M	L	S	5	1	137	203	147
316	M	D	W	4	11	130	185	145									

XIII.—Govan District Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
1	M	L	S	5	6	145	199	155	61	D	D	S	5	6	124	191	146
2	M	M	S	5	8	131	191	145	62	M	L	W	5	6	123	193	146
3	M	M	S	6	1	137	194	151	63	D	D	S	5	6	139	203	155
4	M	D	S	5	8	138	197	154	64	D	L	S	5	11	137	203	148
5	F	L	S	5	5	137	198	152	**65**	D	D	S	5	7	136	193	153
6	D	L	W	5	6	133	203	152	66	M	D	S	5	9	136	199	153
7	D	M	W	5	7	130	181	148	67	D	D	S	5	9	136	192	143
8	M	L	R	5	8	129	190	147	68	D	M	S	4	8	137	192	146
9	M	M	S	5	9	132	196	151	69	M	L	S	5	7	135	196	149
10	M	M	S	5	4	132	189	143	**70**	M	L	S	5	8	139	198	154
11	M	L	S	5	7	132	196	151	71	D	D	S	5	9	142	198	157
12	M	L	S	5	3	133	204	154	72	D	D	S	5	8	138	192	150
13	D	D	S	5	9	138	206	157	73	M	M	S	5	7	136	191	146
14	M	D	S	5	8	154	197	168	74	M	L	S	5	3	138	193	152
15	M	L	S	5	9	137	197	146	**75**	R	M	S	5	8	135	189	148
16	D	L	W	6	1	145	210	159	76	D	M	W	5	8	141	209	156
17	D	D	S	5	7	137	201	154	77	M	M	S	5	6	147	201	159
18	M	L	S	5	8	126	190	151	78	M	D	S	5	7	138	189	158
19	M	L	S	5	7	132	190	144	79	M	D	S	5	11	138	195	154
20	M	L	S	5	9	135	198	152	**80**	D	L	S	5	8	136	189	142
21	M	M	R	5	6	141	201	163	81	M	M	S	5	5	139	193	155
22	M	M	S	5	7	141	192	154	82	M	L	S	5	7	134	196	150
23	M	L	S	5	6	130	192	148	83	M	M	S	5	6	134	196	147
24	R	D	S	5	7	135	191	145	84	M	L	S	5	6	142	192	151
25	M	L	S	5	7	140	199	150	**85**	M	L	S	5	3	133	192	138
26	M	M	S	5	8	135	187	147	86	M	L	S	6	1	137	195	156
27	D	D	S	5	6	126	193	148	87	M	L	C	5	6	135	194	145
28	D	M	S	5	10	134	194	147	88	M	D	S	4	11	135	187	146
29	M	L	S	5	8	141	197	148	89	F	L	S	5	9	143	201	150
30	M	L	W	5	5	135	195	153	**90**	M	D	S	5	5	132	189	141
31	M	L	S	5	2	135	193	149	91	D	D	S	5	8	132	194	148
32	M	M	W	5	10	133	183	145	92	M	L	S	5	5	129	190	149
33	M	L	S	5	5	134	191	144	93	M	M	S	5	7	139	203	154
34	M	M	S	5	6	136	200	145	94	M	M	S	5	6	141	203	150
35	M	L	S	5	6	132	204	146	**95**	M	L	C	5	8	138	199	155
36	M	M	W	5	4	142	202	153	96	M	M	S	5	2	141	188	146
37	M	L	S	5	3	138	196	154	97	M	M	S	5	2	141	196	160
38	M	L	S	5	4	134	189	151	98	M	L	S	5	5	129	186	144
39	M	D	S	5	7	139	199	147	99	M	D	S	5	5	135	194	150
40	M	D	S	5	7	139	197	157	**100**	M	D	S	5	2	134	195	145
41	M	L	S	5	9	149	213	158	101	M	M	W	5	8	137	198	150
42	M	L	S	5	6	140	196	152	102	M	L	S	5	6	136	210	146
43	M	L	S	5	10	135	190	147	103	D	M	S	5	6	139	196	155
44	M	L	S	5	7	135	192	154	104	D	D	S	5	7	137	189	152
45	M	D	S	5	9	145	199	152	**105**	D	M	S	5	5	138	210	158
46	M	L	W	5	11	135	205	161	106	M	M	S	5	7	136	188	154
47	M	D	S	5	5	134	192	145	107	M	M	S	5	5	137	192	155
48	D	M	W	5	3	137	192	152	108	D	L	R	5	7	143	195	158
49	M	L	S	5	6	146	199	162	109	D	L	S	5	1	143	192	152
50	M	L	S	5	9	146	200	150	**110**	M	L	S	5	6	136	195	151
51	M	L	W	5	10	141	200	150	111	M	L	W	5	3	132	189	144
52	M	D	S	5	4	132	190	145	112	M	D	S	5	6	148	202	154
53	M	L	S	5	11	142	196	152	113	M	L	S	5	4	136	193	143
54	M	D	S	5	6	144	210	164	114	M	L	S	5	10	137	205	151
55	M	D	S	5	6	124	190	147	**115**	M	L	S	5	6	136	194	149
56	M	L	S	5	4	132	199	155	116	M	L	S	5	6	139	188	152
57	M	L	S	5	6	131	196	148	117	M	L	S	5	1	132	187	142
58	M	M	S	5	8	129	202	147	118	D	L	S	5	5	132	190	145
59	M	L	S	5	5	134	186	148	119	M	L	S	5	1	123	189	150
60	M	L	S	5	4	132	192	132	**120**	M	L	S	5	4	129	189	146

XIII.—Govan District Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
121	M	M	S	5	6	129	193	147	181	D	L	S	5	9	135	199	153
122	M	L	S	5	8	139	194	152	182	M	M	S	5	8	139	200	152
123	M	M	S	5	1	133	180	147	183	M	L	S	5	4	134	197	152
124	D	M	S	5	10	133	202	153	184	M	D	S	5	7	134	193	142
125	M	L	S	5	9	141	197	157	**185**	M	L	W	5	11	136	191	150
126	D	D	W	5	4	140	208	152	186	M	L	S	5	6	135	194	151
127	D	L	S	5	3	133	197	141	187	M	L	S	5	7	135	194	145
128	D	M	S	5	9	144	210	151	188	M	L	S	5	5	123	187	148
129	M	D	W	5	8	134	196	144	189	D	D	S	5	7	132	201	162
130	M	L	S	4	11	133	178	147	**190**	M	D	S	5	6	136	199	148
131	M	L	S	5	2	130	189	141	191	D	L	S	5	6	148	190	147
132	M	D	S	5	8	143	202	157	192	D	M	S	5	8	133	195	148
133	M	L	S	5	5	134	193	145	193	M	L	S	5	6	136	192	148
134	M	L	S	5	9	138	197	154	194	M	M	S	5	7	136	198	151
135	M	M	S	5	7	137	192	158	**195**	M	L	S	5	10	134	193	148
136	M	L	S	5	5	142	191	155	196	M	L	S	5	6	136	195	151
137	M	L	S	5	11	139	194	150	197	M	M	S	5	6	132	193	155
138	F	L	S	5	8	138	191	148	198	M	L	S	5	6	137	203	154
139	M	L	W	5	5	141	195	147	199	M	D	S	5	4	141	200	157
140	M	L	S	5	5	131	192	145	**200**	M	D	C	5	7	140	195	156
141	D	D	S	5	6	136	195	160	201	D	M	S	6	2	140	215	155
142	F	L	S	5	9	135	198	151	202	M	M	S	5	6	129	192	146
143	D	L	S	5	9	137	201	150	203	M	M	S	5	10	141	197	159
144	M	D	S	5	3	128	188	145	204	M	L	S	5	10	143	205	160
145	M	L	S	5	7	136	195	152	**205**	M	L	S	5	10	142	201	152
146	D	L	S	5	6	135	202	155	206	M	D	S	5	9	144	199	157
147	M	D	S	5	1	134	183	143	207	M	M	S	4	8	126	173	144
148	D	M	S	5	7	133	198	155	208	M	D	W	5	4	136	201	152
149	M	M	S	5	1	138	184	150	209	M	L	S	5	6	137	206	161
150	M	M	S	5	2	139	204	155	**210**	M	L	S	5	5	141	193	152
151	D	M	S	5	6	139	198	147	211	M	L	S	5	11	141	201	159
152	M	L	W	5	6	128	195	149	212	M	L	S	6	0	131	194	152
153	M	L	S	5	6	141	208	153	213	M	L	S	5	1	129	192	148
154	M	L	S	5	4	127	192	135	214	M	M	S	5	4	132	196	155
155	M	L	W	5	8	133	188	157	**215**	D	M	S	5	6	136	198	146
156	M	M	S	5	9	141	197	158	216	M	L	S	5	2	133	202	161
157	M	L	S	5	8	140	205	152	217	M	L	S	5	3	130	188	153
158	M	L	S	5	4	132	187	147	218	M	L	W	5	3	133	198	153
159	M	D	S	5	3	135	187	151	219	R	L	S	5	9	135	195	155
160	D	D	S	5	3	130	200	153	**220**	M	M	S	5	11	126	185	142
161	M	L	S	4	9	125	180	133	221	D	D	S	5	6	135	202	150
162	M	D	S	5	1	126	191	140	222	M	M	S	5	1	138	201	152
163	D	L	S	5	11	134	201	155	223	D	L	S	4	11	142	199	154
164	M	L	S	5	2	132	196	149	224	M	L	S	5	4	131	189	143
165	M	L	S	5	10	132	208	156	**225**	M	L	S	5	5	136	200	151
166	M	D	S	5	6	137	189	146	226	M	L	S	5	6	135	195	162
167	M	L	S	4	3	129	192	140	227	M	L	S	5	6	137	191	154
168	M	D	S	5	8	134	195	147	228	M	M	S	5	7	132	197	150
169	M	L	S	5	0	125	190	151	229	D	M	S	5	4	137	206	157
170	M	M	S	5	0	138	200	150	**230**	M	L	S	5	8	139	202	154
171	M	L	S	6	0	136	203	156	231	M	L	S	5	3	143	194	143
172	M	M	S	5	8	135	191	149	232	R	L	S	5	0	134	184	148
173	M	L	S	5	0	118	202	145	233	M	D	S	5	5	137	198	150
174	M	D	S	5	2	126	192	150	234	M	L	S	5	7	135	207	170
175	M	D	S	5	11	130	195	151	**235**	M	M	S	5	8	137	214	150
176	M	M	S	5	7	137	210	151	236	M	D	S	5	8	140	202	162
177	M	L	S	5	5	127	190	143	237	M	M	W	5	8	145	290	149
178	M	D	R	5	7	127	200	150	238	M	L	S	5	7	136	193	162
179	D	D	W	5	4	139	197	158	239	M	L	S	5	5	136	202	156
180	M	L	S	5	5	137	206	154	**240**	M	L	S	5	7	141	203	157

XIII.—Govan District Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
241	M	D	S	5	5	133	195	144	254	D	M	S	5	10	138	200	154
242	M	L	S	5	7	137	200	150	**255**	M	D	S	5	7	135	196	147
243	M	M	C	5	10	141	200	155	256	M	L	S	5	9	138	188	150
244	M	M	W	5	8	135	192	144	257	M	L	R	5	2	139	190	155
245	M	L	S	5	8	134	201	155	258	M	L	S	5	6	139	207	158
246	M	M	S	5	6	141	193	154	259	M	L	S	5	6	125	195	150
247	D	M	S	5	3	135	185	148	**260**	M	L	S	5	7	133	189	152
248	M	M	S	5	9	134	195	151	261	M	L	S	5	5	130	191	145
249	M	L	W	5	7	139	200	156	262	M	L	S	6	1	133	198	155
250	M	M	S	5	6	137	203	153	263	M	L	S	5	5	133	194	151
251	M	L	S	4	8	136	190	138	264	M	L	S	5	4	134	201	157
252	M	D	S	5	6	138	195	158	**265**	M	L	W	5	10	140	211	158
253	D	L	S	5	7	135	194	152									

XIV.—Haddington District Asylum.

MALES.									MALES.								
1	D	D	S	5	7	137	195	151	**35**	D	L	S	5	11	142	202	155
2	M	L	S	5	6	144	196	156	36	M	L	S	5	10	139	200	157
3	M	L	R	5	6	132	190	154	37	M	D	S	5	11	138	193	156
4	M	L	W	5	4	131	194	149	38	D	M	S	5	5	129	195	155
5	D	D	S	5	7	131	186	142	39	D	L	S	5	8	139	192	145
6	D	D	S	6	1	144	199	151	**40**	M	L	W	5	1	137	198	151
7	M	L	S	5	5	145	202	158	41	M	L	S	5	7	139	190	159
8	M	L	S	5	9	155	205	159	42	M	L	S	5	3	126	191	138
9	D	L	W	4	11	125	186	141	43	M	L	S	5	10	145	205	154
10	M	L	S	5	9	146	204	157	44	D	D	S	5	8	143	198	157
11	W	M	S	5	8	143	199	154	**45**	M	L	S	5	3	133	188	149
12	D	L	S	5	8	152	199	154	46	M	M	W	5	1	137	194	149
13	M	M	S	5	9	137	194	147	47	M	L	W	5	8	143	201	161
14	M	L	S	5	5	134	192	149	48	M	L	S	5	6	125	177	144
15	M	L	S	5	7	140	203	154	49	M	L	S	5	5	139	192	152
16	M	L	S	5	7	137	180	141	**50**	M	L	S	5	2	131	195	153
17	D	M	S	5	8	142	192	149	51	M	L	S	5	8	119	188	141
18	M	L	S	5	7	138	187	149	52	F	L	S	5	7	134	198	160
19	M	L	S	5	8	150	198	153	53	M	L	W	5	4	143	192	155
20	M	L	S	5	7	141	195	158	54	M	L	S	6	0	149	203	158
21	M	L	S	5	5	129	198	149	**55**	D	L	S	6	0	136	192	156
22	M	L	S	5	11	137	198	153	56	F	L	C	5	10	150	194	146
23	M	M	S	5	7	129	186	153	57	D	D	S	5	9	141	199	148
24	D	L	S	5	7	140	197	149	58	M	M	S	5	5	131	196	153
25	M	L	S	5	5	130	185	148	59	M	L	S	5	10	143	200	151
26	M	D	S	5	9	143	207	157	**60**	D	M	S	5	6	129	188	148
27	D	L	S	5	9	141	197	145	61	D	D	W	5	5	131	196	149
28	M	L	S	5	9	126	189	140	62	M	L	S	5	6	145	201	158
29	D	L	S	5	6	134	198	155	63	D	M	W	5	6	133	194	153
30	M	M	S	5	5	138	207	157	64	M	L	S	5	10	134	199	156
31	M	L	S	5	4	139	198	158	**65**	D	L	S	5	1	125	198	143
32	D	M	S	5	6	144	201	156	66	M	L	S	5	4	138	188	151
33	D	L	S	4	9	128	191	141	67	M	L	S	5	3	130	195	145
34	M	L	S	5	6	138	195	151	68	M	L	W	5	6	134	185	150

XV.—Inverness District Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
1	M	M	S	5	5	131	193	151	61	F	M	S	5	6	140	203	155
2	...	M	S	5	5	139	198	153	62	D	M	W	5	7	147	198	154
3	...	M	S	5	6	131	191	146	63	D	M	S	5	8	140	197	156
4	...	L	S	5	1	131	190	158	64	D	D	S	5	5	139	196	157
5	D	D	S	5	4	131	205	154	**65**	F	L	S	5	4	132	197	146
6	D	D	S	5	2	141	209	154	66	D	M	S	5	8	131	201	157
7	R	M	S	6	0	133	194	153	67	M	L	S	5	7	133	198	160
8	...	M	S	5	11	140	202	157	68	...	M	S	5	11	143	198	157
9	...	L	S	5	3	133	187	150	69	...	L	S	5	7	132	195	153
10	...	M	S	5	1	123	192	154	**70**	D	L	S	5	6	131	201	155
11	...	M	R	5	6	129	200	147	71	...	L	S	5	1	127	185	155
12	...	M	S	5	7	127	199	151	72	...	M	S	5	11	125	201	150
13	...	L	S	6	0	141	189	152	73	D	M	S	5	6	140	196	162
14	...	M	S	5	9	139	201	149	74	M	M	S	5	7	152	193	154
15	...	L	S	5	2	131	192	151	**75**	D	M	S	5	6	155	196	154
16	D	M	S	5	4	140	200	152	76	D	D	S	5	5	138	195	153
17	...	L	S	5	3	139	200	160	77	...	M	S	5	3	134	196	151
18	D	M	S	5	9	128	186	154	78	D	L	S	5	6	132	196	154
19	D	D	S	5	7	134	191	146	79	M	M	S	5	11	125	182	149
20	D	M	S	5	5	134	200	154	**80**	D	D	C	5	9	131	200	159
21	D	M	S	5	8	127	193	154	81	D	D	S	5	4	130	185	155
22	D	M	S	5	5	137	199	151	82	D	M	C	5	5	131	188	153
23	..	M	S	5	10	138	213	158	83	D	M	C	5	6	153	198	150
24	...	M	S	5	7	132	194	154	84	M	L	S	5	4	158	205	158
25	...	M	S	5	2	132	197	149	**85**	D	M	S	5	6	139	205	161
26	...	M	S	5	5	131	200	155	86	D	L	S	5	3	130	194	148
27	D	L	S	5	7	125	196	147	87	D	M	S	5	6	151	199	152
28	D	M	S	5	9	133	202	152	88	...	L	S	5	10	133	185	152
29	D	D	S	5	7	146	183	156	89	M	M	S	5	8	144	197	160
30	D	M	S	5	3	134	199	152	**90**	M	M	S	5	4	140	186	152
31	D	M	S	5	4	129	197	146	91	...	M	S	5	6	131	205	160
32	...	L	S	5	7	144	196	151	92	D	M	S	5	7	139	207	158
33	D	L	S	5	11	140	200	155	93	M	M	S	5	4	135	198	156
34	F	L	S	5	4	131	196	151	94	...	L	S	5	7	140	202	156
35	...	M	S	5	7	130	193	166	**95**	M	M	S	5	5	141	198	147
36	M	M	S	4	9	132	196	152	96	M	L	S	6	2	140	207	154
37	...	L	S	5	9	139	200	155	97	D	M	S	5	4	144	187	155
38	...	D	S	5	3	129	200	150	98	M	M	S	5	6	136	200	155
39	M	M	S	5	5	138	193	153	99	D	M	S	5	8	146	211	158
40	D	M	C	5	3	129	186	144	**100**	...	L	S	5	6	137	199	158
41	M	M	S	5	7	130	193	151	101	D	M	S	5	3	131	183	162
42	F	L	W	5	8	138	196	150	102	D	M	S	5	5	134	195	156
43	...	L	S	5	6	133	184	146	103	...	M	S	5	8	139	204	150
44	D	L	S	5	4	131	199	152	104	D	M	S	5	7	133	202	151
45	D	L	S	5	8	141	206	154	**105**	...	M	S	5	7	140	200	149
46	D	M	S	5	7	138	193	151	106	D	M	S	5	4	145	198	154
47	D	M	S	5	3	131	200	157	107	...	M	S	5	7	144	201	149
48	M	L	S	5	6	156	192	148	108	D	M	S	5	3	139	197	156
49	D	M	S	5	5	130	198	146	109	D	D	S	5	2	133	193	149
50	D	M	S	5	7	138	200	148	**110**	D	D	C	5	6	139	201	157
51	F	L	S	5	5	134	191	147	111	...	M	S	5	7	148	201	156
52	...	L	S	5	9	128	193	151	112	...	L	S	5	1	132	191	151
53	...	M	S	5	8	141	200	149	113	D	M	S	5	9	134	196	150
54	..	L	S	5	1	128	190	153	114	D	L	S	5	11	131	196	152
55	D	M	S	5	4	119	171	133	**115**	D	M	S	5	5	132	200	152
56	...	L	S	5	8	139	200	159	116	...	D	S	5	6	140	201	146
57	D	M	S	5	7	130	188	148	117	D	L	S	5	7	136	192	150
58	M	M	S	5	8	139	197	152	118	...	L	S	5	8	155	197	153
59	D	M	S	5	5	133	203	151	119	D	M	S	5	6	144	202	157
60	D	M	S	5	4	130	193	154	**120**	D	M	S	5	4	126	188	143

XV.—Inverness District Asylum.

MALES.

No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
121	M	M	S	5	1	136	198	145
122	D	M	S	5	5	141	199	158
123	D	D	S	5	8	146	203	152
124	...	M	S	5	5	141	207	158
125	...	M	S	5	7	145	204	160
126	D	M	S	5	2	131	200	152
127	D	D	S	5	4	138	198	144
128	D	L	S	5	5	142	198	149
129	M	M	...	5	8	138	198	156
130	..	L	S	5	4	134	201	156
131	D	D	S	5	8	145	193	150
132	...	M	S	5	8	143	193	156
133	D	L	S	5	8	138	191	147
134	D	M	S	5	9	134	184	150
135	...	M	S	5	5	137	204	158
136	...	L	S	5	4	124	195	148
137	D	M	S	5	7	143	194	151
138	M	M	S	5	8	135	200	160
139	D	M	S	5	1	122	185	141
140	M	M	S	5	7	136	191	150
141	D	M	S	5	11	131	199	160
142	M	M	S	5	1	136	195	156
143	...	M	S	5	3	139	197	152
144	M	M	S	6	0	134	194	146
145	D	D	C	6	0	139	192	150
146	D	M	S	5	3	126	199	155
147	D	M	S	5	4	129	196	153
148	M	M	S	5	3	138	190	155
149	D	M	C	5	1	125	188	148
150	M	M	S	5	4	130	190	147
151	D	D	S	5	8	135	200	150
152	F	M	S	5	6	130	204	152
153	M	D	S	5	2	126	192	149
154	D	M	S	5	6	121	193	147
155	M	M	S	5	4	126	190	150
156	M	D	S	5	6	137	199	147
157	D	D	S	5	7	134	199	164
158	D	M	S	5	9	136	197	160
159	R	L	S	5	9	138	203	160
160	D	M	S	5	9	137	197	150
161	D	M	S	5	10	140	203	157
162	D	M	S	5	8	135	208	153
163	D	M	S	5	7	130	195	150
164	D	M	S	5	6	140	198	151
165	...	M	S	5	6	140	200	155
166	M	M	S	5	6	136	184	146
167	M	M	S	5	10	134	191	152
168	D	M	W	5	8	135	198	154
169	M	M	S	5	6	131	190	152
170	...	M	S	6	0	150	206	162
171	D	D	S	5	3	124	192	149
172	D	L	W	5	2	136	185	150
173	D	D	S	5	8	131	198	153
174	M	M	S	5	7	133	197	150
175	D	D	S	5	6	124	192	154
176	D	M	S	5	4	134	192	155
177	D	M	S	5	7	134	197	156
178	...	M	S	5	6	133	200	160
179	D	M	S	5	9	138	188	166
180	D	M	S	5	9	135	188	155
181	D	D	S	5	3	129	198	155
182	M	M	S	6	0	140	197	161
183	F	L	S	5	3	126	185	147
184	D	D	S	5	8	138	198	157
185	M	M	S	5	8	133	196	151
186	...	M	S	5	5	134	190	149
187	D	M	S	5	8	139	198	152
188	...	L	S	5	7	130	193	154
189	M	M	S	5	6	144	197	160
190	D	M	S	5	8	153	190	154
191	M	L	S	5	8	139	198	155
192	D	M	S	5	6	131	192	156
193	M	M	S	5	5	126	182	145
194	D	D	S	5	6	127	193	150
195	D	D	S	5	6	139	195	153
196	...	M	S	5	4	135	195	157
197	D	M	S	5	5	132	196	154
198	D	M	S	5	8	135	201	147
199	D	D	S	5	8	136	195	155
200	D	M	S	5	7	128	188	147
201	D	D	S	5	8	134	193	155
202	D	M	W	5	9	138	191	156
203	D	M	S	5	7	129	199	154
204	D	M	S	5	8	148	194	162
205	D	M	S	5	4	137	193	154
206	...	M	S	5	5	136	199	146
207	M	M	S	5	11	149	197	165
208	M	M	S	5	5	131	197	153
209	...	M	S	6	0	138	205	154
210	D	M	S	6	0	138	197	152
211	M	M	C	5	4	140	191	157
212	...	M	S	5	11	140	201	161
213	D	D	S	5	7	139	182	147
214	M	M	S	5	7	141	206	153
215	D	M	S	5	6	133	203	157
216	...	M	S	5	3	127	186	152
217	M	M	S	5	6	145	204	155
218	D	D	S	5	6	135	195	152
219	D	M	S	5	7	147	201	158
220	...	M	S	5	3	136	193	150
221	D	M	S	6	0	135	197	153
222	M	D	S	5	7	145	190	153
223	M	M	S	5	8	143	206	157
224	D	M	S	5	6	143	195	160
225	M	D	S	5	8	142	198	157
226	D	M	S	5	7	135	202	165
227	F	L	S	5	9	140	196	158
228	D	D	S	...		124	186	139
229	...	M	S	...		134	193	158
230	D	M	S	5	10	132	196	154
231	...	M	S	...		132	201	151
232	...	M	S	...		136	193	150
233	...	M	S	...		133	205	151
234	M	M	S	...		137	193	155
235	...	M	S	...		135	200	155
236	D	M	S	...		135	189	154
237	...	M	S	...		126	187	153
238	..	M	S	...		136	195	156
239	...	M	S	...		131	189	150
240	M	M	S	5	7	140	199	154

XV.—Inverness District Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
241	...	M	S	5	4	139	196	150	267	D	M	S	5	5	132	186	151
242	M	M	S	5	11	134	206	159	268	M	M	S	5	7	139	194	146
243	...	L	S	5	7	133	193	156	269	M	M	S	5	7	140	196	151
244	...	L	S	5	10	139	199	157	**270**	M	M	S	5	7	147	217	164
245	D	D	W	5	4	131	195	150	271	D	M	S	6	0	138	198	150
246	D	M	S	5	5	124	186	150	272	M	M	S	5	7	126	187	148
247	D	M	S	5	4	129	191	149	273	D	M	S	5	9	137	198	161
248	D	M	S	5	6	139	202	158	274	R	D	C	5	3	126	190	150
249	D	M	S	5	5	134	193	151	**275**	D	M	W	5	7	133	201	157
250	...	M	S	5	10	129	190	155	276	...	M	S	5	8	127	191	149
251	D	M	S	5	10	139	195	151	277	D	M	S	5	7	133	192	151
252	M	M	S	5	5	137	189	161	278	M	M	S	5	6	137	203	164
253	D	M	S	5	4	131	187	149	279	D	M	S	5	8	159	193	153
254	D	M	S	5	6	129	195	152	**280**	D	M	S	5	8	138	206	152
255	...	M	S	5	0	126	175	141	281	M	M	S	6	0	140	202	157
256	D	M	S	5	5	138	191	154	282	M	M	S	5	7	142	197	164
257	...	M	S	5	7	137	185	145	283	D	M	S	5	8	134	193	154
258	D	M	C	5	3	137	204	153	284	R	M	S	5	3	127	193	153
259	D	M	S	5	4	118	178	132	**285**	D	M	S	5	4	134	204	152
260	...	D	S	5	9	146	196	149	286	D	M	S	5	7	130	195	157
261	D	M	S	5	6	126	190	155	287	D	M	S	5	7	131	199	148
262	...	M	S	5	7	133	195	149	288	D	M	S	5	6	136	198	156
263	D	M	S	5	5	127	199	155	289	M	M	S	5	8	134	205	153
264	M	M	S	5	6	136	198	154	**290**	M	D	S	5	6	138	198	158
265	...	M	S	5	10	148	202	155	291	D	D	S	5	10	144	205	162
266	D	M	S	5	7	119	187	130									

XVI.—Lanark District Asylum.

MALES.									MALES.								
1	M	L	S	5	7	137	198	153	26	M	L	W	5	6	129	196	151
2	D	D	W	5	9	135	196	151	27	M	L	S	5	6	141	194	149
3	D	M	S	5	4	137	194	153	28	D	L	S	5	3	139	199	153
4	M	L	S	5	8	134	193	154	29	D	L	W	5	4	151	212	157
5	D	L	S	5	6	139	201	161	**30**	M	M	S	5	5	145	217	160
6	M	D	S	5	4	133	187	146	31	M	D	S	5	9	138	197	158
7	M	L	S	5	6	137	183	149	32	R	L	R	5	7	138	198	162
8	M	L	S	5	6	137	190	149	33	D	D	S	6	1	146	202	149
9	M	L	S	5	6	139	194	156	34	M	M	R	5	5	139	203	155
10	D	M	S	5	5	141	198	147	**35**	D	L	W	5	6	133	192	146
11	M	L	S	5	6	140	197	149	36	D	D	W	5	6	136	192	159
12	M	M	W	5	5	139	190	143	37	D	D	W	5	5	136	193	150
13	D	M	W	5	5	138	196	158	38	M	L	W	5	9	136	203	158
14	D	M	S	5	4	148	198	149	39	M	L	W	5	4	130	186	146
15	M	L	S	5	8	142	199	153	**40**	M	L	S	5	4	132	198	151
16	M	D	S	6	0	141	204	153	41	D	D	R	5	5	144	199	154
17	D	D	S	5	3	133	188	144	42	D	L	S	5	4	139	187	158
18	M	L	S	5	3	125	187	149	43	D	M	S	5	4	142	193	151
19	M	L	S	5	6	143	203	156	44	D	L	W	5	7	142	200	152
20	D	D	W	5	7	144	198	145	**45**	M	L	S	5	3	133	187	143
21	D	D	S	5	10	144	204	152	46	M	M	W	5	11	141	204	151
22	M	L	W	5	8	136	193	144	47	F	M	S	5	4	137	199	149
23	M	M	S	5	7	143	206	152	48	M	L	S	5	6	135	198	152
24	M	L	W	5	10	151	208	152	49	D	D	S	5	6	142	201	153
25	M	L	W	5	7	144	194	157	**50**	M	M	S	5	1	144	205	156

XVI.—Lanark District Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
51	D	M	S	5	7	144	202	164	111	M	M	S	5	6	134	195	155
52	M	L	W	5	5	142	196	156	112	M	M	S	5	5	126	190	142
53	D	D	S	5	6	144	205	158	113	M	M	S	5	7	130	190	156
54	D	D	S	5	5	137	194	141	114	D	L	S	5	9	141	204	160
55	M	L	S	5	9	139	199	150	**115**	M	L	S	5	1	126	187	148
56	D	L	W	5	4	150	203	147	116	M	L	S	5	2	130	196	152
57	M	M	S	5	5	136	188	150	117	M	L	W	5	3	135	195	150
58	M	M	S	5	8	134	201	155	118	M	L	S	5	6	138	198	154
59	D	L	S	5	6	135	193	143	119	M	L	S	5	9	139	202	153
60	M	M	S	5	7	143	203	164	**120**	D	D	S	5	9	139	195	154
61	D	L	S	5	6	145	203	160	121	D	M	W	5	5	141	201	153
62	M	M	S	5	7	139	196	152	122	D	M	W	5	5	142	197	152
63	D	L	W	5	7	137	199	158	123	M	D	S	5	5	130	190	140
64	M	M	S	5	5	138	193	153	124	M	L	S	5	4	132	195	153
65	M	L	S	5	2	142	204	162	**125**	M	M	C	5	6	133	195	147
66	M	M	S	5	9	139	201	146	126	D	D	W	5	8	136	198	152
67	M	L	S	5	9	142	199	160	127	D	D	W	4	6	133	185	150
68	D	D	S	5	7	142	207	153	128	M	L	S	5	7	140	190	150
69	M	M	R	5	4	132	186	146	129	D	D	S	5	9	142	193	142
70	M	M	W	5	1	137	193	156	**130**	R	L	S	5	7	141	204	153
71	M	L	R	5	7	143	200	153	131	D	D	W	5	3	146	190	153
72	M	M	R	5	5	135	198	154	132	M	L	S	5	2	137	188	147
73	D	D	W	6	1	131	193	149	133	D	L	S	5	4	138	191	147
74	F	L	S	5	6	142	196	155	134	D	M	S	5	4	142	196	150
75	M	M	C	5	0	139	199	148	**135**	D	M	S	5	8	131	197	149
76	D	D	S	5	8	139	192	147	136	M	L	S	5	6	130	194	149
77	D	M	W	5	5	137	190	154	137	D	L	S	5	5	131	189	136
78	D	D	W	5	4	129	200	144	138	D	D	S	5	5	133	201	154
79	D	L	S	5	4	133	193	148	139	D	D	S	5	3	138	201	153
80	M	M	S	5	2	129	186	153	**140**	D	L	W	5	3	136	191	139
81	M	L	S	5	4	133	184	140	141	M	M	S	5	4	140	193	150
82	F	L	S	5	6	134	188	143	142	D	L	C	5	3	139	200	151
83	M	L	S	5	6	142	194	152	143	M	L	R	5	5	136	192	147
84	D	L	S	5	4	121	183	140	144	M	L	W	5	7	140	199	159
85	M	M	S	5	8	140	199	144	**145**	M	L	S	5	5	139	195	145
86	D	D	S	5	10	140	202	153	146	M	L	S	5	4	143	201	159
87	M	M	S	5	11	135	197	151	147	F	L	W	5	3	133	188	147
88	M	L	S	5	4	136	189	147	148	D	M	S	4	11	137	187	150
89	M	L	S	5	3	143	191	152	149	M	L	S	5	1	132	189	146
90	M	L	S	5	7	144	205	149	**150**	D	D	S	5	5	128	183	142
91	M	M	S	5	7	137	192	154	151	M	M	S	5	9	139	196	150
92	M	L	S	5	10	136	188	160	152	M	M	S	5	5	127	193	152
93	D	L	S	5	6	135	202	150	153	D	D	S	5	4	135	183	143
94	M	L	S	5	5	145	193	154	154	D	L	S	5	6	134	191	150
95	M	D	W	5	5	139	202	160	**155**	D	M	S	5	4	136	197	153
96	D	D	W	5	4	140	202	147	156	M	L	S	5	8	145	198	154
97	M	L	S	5	6	142	209	157	157	D	M	S	5	10	148	203	164
98	M	M	S	5	9	146	201	159	158	M	L	S	5	9	139	192	150
99	D	M	S	5	10	133	193	146	159	D	L	W	5	4	142	198	148
100	D	M	S	5	1	142	206	156	**160**	F	D	W	5	4	141	196	151
101	M	M	S	5	6	140	196	154	161	D	D	S	5	7	141	204	152
102	M	L	S	5	6	133	189	144	162	M	L	W	5	6	131	183	134
103	M	M	S	5	7	130	186	148	163	M	L	S	5	7	140	196	144
104	F	L	W	5	8	135	199	158	164	M	L	S	5	4	138	203	153
105	M	L	W	5	6	138	202	149	**165**	M	L	W	5	10	152	206	159
106	M	L	R	5	6	140	191	152	166	M	M	S	5	7	144	208	159
107	F	L	S	5	6	130	197	152	167	M	L	W	5	7	139	198	157
108	M	L	S	5	5	134	203	154	168	D	D	S	5	0	144	191	153
109	M	M	S	5	6	138	197	148	169	M	L	W	5	8	143	197	153
110	D	L	S	5	2	133	192	149	**170**	M	L	W	5	4	143	203	156

XVI.—Lanark District Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
171	M	M	S	4	11	142	198	148	231	M	L	S	5	9	134	189	139
172	M	L	S	5	8	136	195	150	232	M	D	S	5	3	136	192	157
173	D	D	S	5	1	127	174	130	233	M	L	S	5	3	135	196	151
174	M	L	S	5	6	131	201	148	234	D	L	S	5	2	138	197	148
175	D	L	S	5	6	140	195	150	**235**	D	L	S	5	5	137	197	155
176	M	M	S	5	5	135	200	150	236	M	M	S	5	3	135	195	155
177	M	L	S	5	9	150	206	158	237	M	M	W	5	4	139	195	150
178	F	L	W	5	8	146	203	161	238	M	D	S	5	5	138	201	147
179	D	M	W	5	7	131	184	142	239	M	L	W	5	8	129	208	162
180	D	D	W	5	7	133	200	162	**240**	M	L	S	5	5	139	208	159
181	M	L	S	5	5	133	192	151	241	M	M	R	5	9	142	203	158
182	M	L	S	5	6	144	196	152	242	M	L	S	5	4	142	199	161
183	M	D	S	5	8	138	192	149	243	M	L	S	5	6	135	193	149
184	M	L	S	5	11	138	202	150	244	M	L	W	5	7	144	200	153
185	D	D	S	5	5	128	177	141	**245**	D	D	S	5	6	142	204	155
186	M	M	S	5	5	130	190	150	246	M	D	W	5	4	135	192	150
187	M	M	S	5	5	134	196	156	247	D	L	S	5	4	144	199	150
188	M	L	S	5	2	137	190	144	248	D	D	S	5	8	142	190	150
189	M	M	S	5	11	138	201	150	249	D	L	S	5	0	144	185	159
190	M	M	S	5	7	142	205	155	**250**	M	L	S	5	4	138	201	145
191	M	L	S	6	2	141	193	152	251	D	D	R	5	6	142	193	155
192	M	M	W	5	2	132	191	149	252	D	D	S	5	6	144	203	157
193	D	D	S	5	8	136	203	152	253	D	L	S	5	6	133	204	155
194	M	M	S	5	5	140	195	145	254	M	L	S	5	5	128	197	148
195	D	L	S	5	3	131	195	158	**255**	D	D	W	5	6	141	197	154
196	M	D	S	5	2	131	192	150	256	D	L	S	5	6	150	194	158
197	M	L	S	5	8	136	199	157	257	M	L	R	5	3	148	195	143
198	M	M	S	5	5	142	195	153	258	M	L	S	5	1	136	195	150
199	D	D	S	5	5	138	190	147	259	D	D	S	5	6	150	199	157
200	F	L	W	5	7	139	202	149	**260**	D	M	S	5	5	155	200	152
201	R	L	S	5	9	134	193	152	261	D	D	S	5	7	141	203	150
202	M	D	W	5	2	129	188	153	262	M	D	S	5	1	142	195	155
203	D	M	C	5	3	132	194	148	263	M	L	S	5	2	139	189	144
204	M	...	C	5	7	133	193	151	264	D	D	S	5	6	136	190	144
205	D	L	W	5	4	133	193	152	**265**	F	L	S	5	7	148	203	156
206	F	L	S	5	3	139	207	156	266	M	D	W	4	11	151	199	153
207	M	L	S	5	5	130	198	149	267	D	L	S	5	7	143	194	153
208	D	D	S	6	1	137	197	152	268	D	L	W	5	4	139	199	148
209	M	L	S	5	4	140	186	152	269	D	D	S	5	3	149	191	150
210	M	L	S	5	1	137	187	155	**270**	D	L	S	5	6	135	206	147
211	M	L	S	5	4	134	201	148	271	D	M	S	5	8	145	199	158
212	M	L	S	5	3	139	189	138	272	M	L	S	5	5	135	194	150
213	D	M	S	5	3	134	197	156	273	M	L	S	5	8	140	197	156
214	M	L	S	5	9	137	202	148	274	D	L	W	5	8	144	194	155
215	M	D	S	5	8	137	187	146	**275**	D	M	W	5	7	140	200	152
216	M	D	S	5	8	141	198	153	276	D	D	S	5	5	146	199	147
217	D	D	S	5	6	142	195	147	277	M	M	S	5	4	140	203	150
218	M	M	S	5	3	145	198	151	278	D	M	S	5	5	132	190	145
219	D	L	S	5	5	155	209	165	279	M	D	W	5	1	139	191	150
220	F	M	S	...		118	163	125	**280**	M	M	S	5	5	151	202	157
221	M	L	S	5	2	138	197	151	281	M	L	S	5	6	143	211	158
222	D	D	S	5	7	140	194	156	282	M	L	W	5	1	143	190	147
223	M	L	R	5	8	143	210	161	283	M	L	W	5	5	146	196	148
224	M	L	W	5	4	136	199	150	284	M	L	R	5	4	142	198	160
225	M	L	S	5	6	140	199	154	**285**	D	L	S	5	5	132	198	132
226	M	L	W	5	8	143	197	162	286	M	M	S	5	1	140	202	147
227	M	L	S	5	5	139	202	163	287	M	M	S	5	9	142	203	149
228	M	D	S	5	2	134	189	145	288	D	D	W	5	4	144	208	151
229	D	M	W	5	6	128	193	145	289	D	D	S	5	2	127	186	145
230	M	M	S	5	6	140	206	155	**290**	D	D	W	5	8	144	195	149

XVI.—Lanark District Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
291	M	L	S	5	11	139	198	161	339	M	L	S	5	0	129	187	142
292	M	L	S	5	9	131	200	145	**340**	M	L	S	5	5	142	197	151
293	D	L	W	5	3	144	202	152	341	M	L	S	5	6	145	193	153
294	M	L	S	5	10	135	200	157	342	D	L	S	5	6	141	185	145
295	M	L	S	5	5	142	206	157	343	M	L	S	6	1	141	194	165
296	M	L	S	5	5	140	198	152	344	M	M	W	5	8	138	198	150
297	M	L	S	5	8	140	201	154	**345**	M	L	S	5	9	144	190	148
298	M	D	W	5	4	135	197	147	346	M	L	S	5	8	140	205	153
299	M	L	S	5	8	139	197	152	347	M	L	S	5	8	141	192	153
300	M	L	W	5	6	139	190	155	348	M	D	S	5	4	132	183	143
301	D	L	S	5	3	138	204	153	349	M	L	S	5	8	143	198	155
302	M	L	S	5	7	139	185	144	**350**	F	L	S	5	7	130	192	155
303	R	L	S	6	0	140	201	155	351	M	L	W	5	6	143	200	155
304	M	D	S	5	6	138	188	150	352	M	M	S	5	5	131	188	145
305	D	L	S	5	1	135	190	147	353	M	L	S	5	7	143	191	147
306	D	L	W	5	6	138	197	151	354	M	L	S	5	6	145	200	152
307	M	L	S	5	4	134	190	148	**355**	M	L	S	5	5	144	207	159
308	M	L	R	5	5	128	192	147	356	M	M	S	5	8	142	194	155
309	M	L	S	5	2	130	191	149	357	D	D	S	5	2	134	188	156
310	D	M	S	5	8	142	201	160	358	M	M	S	5	7	143	204	162
311	M	L	R	5	7	129	198	146	359	M	L	S	5	7	144	204	147
312	D	D	W	5	7	136	195	148	**360**	M	L	W	5	6	139	192	145
313	M	L	S	5	4	134	185	148	361	D	L	S	5	7	133	197	151
314	M	L	W	5	6	132	201	147	362	D	M	S	5	7	149	200	153
315	M	L	S	5	6	142	207	157	363	M	M	S	5	5	146	195	158
316	M	D	W	5	6	135	198	152	364	D	D	W	5	11	141	195	151
317	M	L	S	5	7	126	184	143	**365**	D	L	S	5	6	137	190	155
318	M	L	S	5	7	140	198	145	366	D	L	S	5	0	165	228	194
319	D	L	S	5	4	141	188	148	367	M	L	S	5	7	141	197	146
320	M	L	S	5	1	137	191	154	368	M	L	S	5	7	141	199	149
321	F	L	R	5	4	138	185	155	369	M	M	W	5	8	135	202	149
322	D	D	S	5	5	134	190	158	**370**	M	L	S	5	3	135	199	157
323	M	L	S	5	10	134	204	155	371	F	M	W	5	7	135	190	155
324	M	L	R	5	7	136	198	153	372	M	L	S	5	5	134	183	154
325	D	M	W	5	7	136	196	154	373	M	L	S	5	3	131	200	150
326	R	L	S	5	11	134	194	143	374	R	L	S	5	3	137	196	152
327	M	L	W	5	8	144	196	155	**375**	M	M	S	5	9	135	194	159
328	D	L	S	5	6	139	191	152	376	D	M	S	5	2	134	188	148
329	M	L	S	5	11	137	193	144	377	M	L	S	5	2	146	201	156
330	D	D	W	5	5	137	203	155	378	D	D	W	5	2	134	188	148
331	M	L	W	5	5	135	188	147	379	M	L	S	5	6	138	193	152
332	M	M	W	5	5	133	194	142	**380**	D	L	S	5	4	134	198	162
333	M	L	S	5	4	139	193	147	381	R	M	S	5	8	141	199	125
334	M	L	S	5	4	138	191	152	382	M	L	S	5	4	139	194	149
335	M	L	S	5	10	135	198	151	383	D	M	S	5	6	137	200	156
336	D	M	S	5	6	145	193	157	384	M	D	W	5	2	132	183	151
337	D	L	S	5	9	133	201	155	**385**	F	L	S	5	5	133	185	143
338	D	D	S	5	10	141	200	160	386	D	D	W	5	6	142	194	148

XVII.—Midlothian District Asylum.

1	D	D	S	5	8	150	196	162	8	D	L	S	5	8	148	192	163
2	D	D	W	5	2	131	197	141	9	M	M	S	5	6	145	194	153
3	M	L	S	5	6	146	195	149	**10**	D	L	S	5	9	143	198	160
4	F	M	W	5	1	157	218	157	11	M	L	W	5	6	141	206	154
5	D	M	S	5	3	128	182	138	12	D	L	S	5	7	155	191	150
6	F	L	S	5	3	133	190	152	13	M	L	S	5	5	141	198	149
7	M	L	S	5	4	141	187	152	14	M	L	S	5	5	141	202	152

XVII.—Midlothian District Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
15	M	L	S	5	9	145	202	159	**75**	M	M	S	5	5	145	195	158
16	D	L	S	5	3	142	202	155	76	D	D	S	5	5	135	190	149
17	D	L	S	5	6	145	206	151	77	D	L	S	5	3	143	201	162
18	M	L	S	5	2	137	199	155	78	D	L	S	5	10	156	202	158
19	M	L	S	5	4	137	189	150	79	M	L	S	5	6	135	191	150
20	M	L	S	5	11	141	196	146	**80**	M	L	S	5	10	142	195	146
21	M	L	S	5	9	149	198	157	81	D	M	S	5	7	133	191	146
22	F	M	S	4	11	132	190	147	82	M	L	W	5	10	146	200	148
23	M	M	S	5	1	125	188	140	83	D	D	S	5	4	142	195	156
24	D	D	S	5	6	141	204	157	84	M	D	W	5	11	143	200	155
25	D	M	S	5	11	140	190	155	**85**	D	M	S	5	7	143	193	152
26	M	D	W	5	3	141	190	146	86	M	D	S	5	6	139	206	151
27	M	L	R	5	6	145	199	157	87	M	L	S	5	5	137	194	148
28	M	L	S	5	7	140	192	151	88	M	D	S	5	9	142	195	157
29	M	M	S	5	4	144	185	150	89	D	L	S	5	6	134	192	144
30	M	L	S	5	8	145	194	159	**90**	M	L	S	5	11	141	191	142
31	D	L	S	5	8	137	198	155	91	M	M	S	5	7	135	194	154
32	R	L	S	5	3	140	197	147	92	M	L	S	5	5	142	192	162
33	M	L	S	5	9	142	202	161	93	M	L	S	5	8	133	183	151
34	D	M	S	5	5	140	195	155	94	D	L	S	5	7	140	197	145
35	D	M	S	5	8	135	184	149	**95**	M	L	W	5	4	131	198	144
36	M	L	S	5	7	133	196	144	96	D	L	S	5	8	140	192	148
37	D	D	S	5	8	140	205	160	97	M	L	S	5	7	137	187	143
38	M	L	S	5	3	127	190	150	98	F	L	S	5	9	136	194	150
39	M	L	S	5	11	137	197	157	99	M	D	S	5	11	141	196	145
40	D	D	S	5	6	133	193	143	**100**	F	L	S	5	3	143	191	152
41	D	L	S	5	7	137	192	158	101	M	L	S	5	7	143	198	147
42	M	L	S	5	6	139	196	151	102	F	L	S	5	8	142	200	156
43	D	L	S	5	10	153	204	154	103	D	L	S	5	6	137	193	148
44	F	L	R	5	5	128	198	155	104	M	L	W	5	7	145	197	153
45	M	L	S	5	7	147	197	150	**105**	D	L	S	5	9	139	190	150
46	D	L	S	5	8	137	188	151	106	D	L	S	5	8	138	201	150
47	M	M	S	5	10	139	197	151	107	F	L	W	5	4	134	197	158
48	M	L	S	5	6	139	198	159	108	F	M	S	5	7	145	188	143
49	D	L	S	5	8	136	200	150	109	D	D	S	5	3	132	189	141
50	D	L	S	5	5	141	197	148	**110**	M	L	S	5	4	140	198	156
51	D	M	S	5	11	142	199	150	111	F	L	S	5	8	149	197	151
52	M	L	S	5	8	143	196	144	112	M	M	S	5	2	134	188	142
53	M	L	W	5	4	132	191	141	113	F	M	S	5	3	139	195	147
54	M	M	W	5	2	141	190	156	114	D	M	S	5	10	145	205	158
55	F	L	S	5	5	136	191	143	**115**	D	D	S	5	4	134	183	149
56	M	L	W	5	7	140	200	153	116	D	D	S	5	7	139	190	154
57	M	D	S	5	2	137	187	157	117	M	M	S	5	5	131	192	151
58	M	L	S	5	4	140	190	150	118	M	L	S	5	7	152	217	157
59	M	D	W	5	6	152	197	166	119	F	L	S	5	4	142	201	151
60	D	L	S	5	6	150	198	150	**120**	M	L	S	5	8	140	203	149
61	D	L	S	5	5	129	188	148	121	R	L	...	5	7	140	202	154
62	M	M	S	5	7	140	187	140	122	M	L	W	5	8	143	190	151
63	M	D	W	5	2	130	187	140	123	M	L	S	5	4	142	191	143
64	M	L	W	5	9	140	206	155	124	M	M	R	5	5	148	181	147
65	M	L	S	5	7	149	204	158	**125**	D	L	S	5	8	140	195	156
66	M	M	S	6	0	145	197	154	126	D	M	S	5	6	135	190	140
67	F	L	S	5	5	136	204	158	127	M	L	S	5	5	138	192	155
68	R	L	S	5	8	149	196	152	128	M	L	S	5	8	134	205	152
69	D	M	S	5	2	140	182	137	129	F	L	S	5	5	138	195	163
70	D	M	S	5	11	144	195	147	**130**	M	L	S	5	4	147	195	149
71	M	L	S	5	7	143	194	151	131	M	M	S	5	6	136	196	156
72	D	D	S	5	10	139	188	145	132	D	L	S	4	2	134	162	145
73	M	L	S	5	8	133	187	146	133	M	L	S	5	9	148	192	152
74	D	D	S	5	4	143	198	155									

XVIII.—Perth District Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
1	D	D	W	5	1	138	195	151	61	M	L	S	5	7	136	196	151
2	M	M	W	5	6	142	198	155	62	M	D	S	5	11	134	202	161
3	M	D	W	5	3	148	194	154	63	F	M	R	5	3	127	181	151
4	D	D	R	5	7	141	190	147	64	F	L	S	5	7	136	194	157
5	M	D	S	5	4	135	190	147	**65**	F	M	S	5	8	141	192	158
6	D	D	S	5	2	127	195	149	66	D	D	S	5	9	135	193	155
7	D	D	S	5	7	142	208	175	67	M	D	R	5	6	150	203	156
8	D	D	W	5	7	138	197	155	68	F	M	S	5	5	131	190	150
9	M	M	S	5	3	132	183	157	69	F	D	S	4	10	142	182	152
10	D	D	S	5	7	137	196	156	**70**	M	D	S	5	8	140	192	146
11	F	D	S	5	8	150	197	161	71	D	L	W	5	0	128	193	140
12	D	M	S	5	7	138	193	152	72	D	D	S	5	6	131	182	150
13	F	D	S	5	5	136	187	152	73	M	M	S	5	10	141	206	155
14	F	M	S	5	6	136	195	156	74	D	L	S	5	8	138	199	152
15	M	D	S	5	5	135	189	149	**75**	F	M	S	5	5	129	179	140
16	D	D	S	5	8	131	193	153	76	D	L	S	5	9	154	215	164
17	D	M	S	5	6	132	187	149	77	M	M	S	5	10	145	203	154
18	M	D	W	5	7	138	186	138	78	M	M	W	5	9	136	198	151
19	M	D	W	5	7	142	195	148	79	D	D	W	5	3	136	192	150
20	M	D	W	5	8	146	195	156	**80**	M	L	S	5	4	139	202	158
21	M	M	W	5	5	139	195	146	81	M	M	S	5	7	149	210	155
22	M	M	W	5	2	134	191	142	82	D	D	S	5	2	132	187	141
23	M	D	S	5	8	142	193	152	83	D	M	S	5	3	134	189	153
24	D	D	W	5	9	137	203	153	84	D	M	S	5	5	151	195	148
25	D	D	S	5	6	137	194	144	**85**	D	M	W	5	7	146	202	155
26	D	D	S	5	11	150	198	159	86	D	M	S	4	11	137	186	153
27	F	L	S	5	8	140	192	143	87	F	L	W	5	8	148	199	155
28	M	M	S	5	5	134	192	146	88	M	L	W	5	7	142	189	154
29	M	M	S	5	4	138	200	158	89	F	L	W	5	6	140	191	148
30	D	D	S	5	7	138	192	155	**90**	M	M	S	5	1	140	199	156
31	F	L	W	5	3	140	187	156	91	M	L	S	5	6	141	194	142
32	D	D	S	5	0	141	192	152	92	D	L	S	5	5	148	198	158
33	R	L	S	5	6	148	191	152	93	M	L	S	5	5	140	196	150
34	D	M	W	5	7	143	203	152	94	D	M	W	5	1	154	191	150
35	M	D	S	5	9	152	199	151	**95**	D	L	W	5	4	134	182	151
36	D	D	S	5	5	129	195	162	96	D	L	S	5	9	145	195	156
37	M	L	S	5	8	135	193	150	97	D	M	S	5	10	138	199	159
38	D	D	S	5	8	139	197	154	98	F	L	S	5	3	135	187	150
39	D	D	S	5	7	138	199	146	99	D	D	S	6	1	155	217	161
40	D	M	S	5	5	138	195	154	**100**	D	M	S	5	2	137	199	157
41	F	L	S	5	9	153	211	163	101	M	M	S	5	9	137	200	153
42	D	D	S	5	9	137	193	150	102	M	L	S	5	6	139	197	147
43	D	D	S	5	3	139	195	156	103	D	M	S	5	6	137	195	142
44	M	D	W	5	5	134	193	156	104	D	L	C	5	5	130	184	140
45	D	D	S	5	6	146	188	150	**105**	F	L	S	5	9	137	197	161
46	D	D	W	5	6	143	197	155	106	D	M	S	5	6	130	192	143
47	D	D	S	5	7	134	192	147	107	D	D	S	5	7	142	198	154
48	D	D	S	5	8	135	201	155	108	D	M	S	5	4	133	194	147
49	D	D	S	5	0	139	201	153	109	M	M	R	5	7	137	204	155
50	D	D	S	5	7	134	206	150	**110**	F	L	W	5	3	141	195	146
51	R	D	S	5	10	148	196	157	111	M	D	C	5	4	139	182	151
52	D	M	S	5	5	127	179	140	112	D	D	S	5	10	141	198	156
53	M	L	S	5	5	138	198	149	113	M	L	S	5	11	151	200	156
54	D	D	S	5	9	141	204	151	114	D	M	S	4	9	130	192	151
55	D	D	W	6	0	133	198	149	**115**	D	D	S	5	2	135	191	153
56	D	M	S	5	7	131	194	156	116	D	D	S	5	6	141	193	148
57	M	D	S	5	10	140	202	155	117	M	M	S	5	9	143	202	147
58	D	D	S	5	7	136	201	150	118	D	D	S	5	3	139	184	145
59	M	D	S	5	11	143	201	154	119	M	M	S	5	3	135	193	162
60	D	M	S	5	5	141	205	149	**120**	D	D	S	5	8	140	201	157

XVIII.—Perth District Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
121	D	D	S	5	4	148	199	151	147	D	M	S	5	6	150	202	158
122	M	L	S	5	10	147	206	166	148	M	M	S	5	9	139	199	154
123	M	M	S	5	7	143	199	154	149	M	M	S	5	9	143	205	158
124	M	M	S	5	5	139	201	155	**150**	D	D	S	5	7	130	198	154
125	F	L	S	5	8	144	201	159	151	D	M	S	5	1	153	198	156
126	F	L	S	5	7	140	188	149	152	D	D	S	5	10	146	201	154
127	R	L	S	5	7	143	201	161	153	D	M	S	5	10	142	204	156
128	D	M	S	5	8	144	193	146	154	D	D	W	5	3	143	196	151
129	M	M	S	5	4	132	197	151	**155**	F	M	R	5	5	153	201	156
130	D	D	S	5	8	135	187	143	156	D	M	S	5	4	137	196	149
131	D	M	S	5	6	138	199	154	157	D	D	S	5	2	128	181	153
132	D	D	S	5	7	149	193	142	158	D	M	S	5	5	139	196	156
133	D	D	C	6	0	136	193	151	159	D	M	W	5	7	146	202	153
134	M	M	S	5	8	128	191	161	**160**	M	M	S	5	9	148	192	150
135	D	D	S	5	6	146	201	159	161	M	M	S	5	4	131	193	143
136	M	...	S	5	5	129	185	139	162	D	M	R	5	2	133	189	153
137	M	L	W	5	8	142	204	156	163	F	M	W	5	3	134	182	141
138	M	L	R	5	8	139	194	153	164	M	M	W	5	8	135	203	155
139	D	D	S	5	5	149	197	156	**165**	D	M	S	5	8	144	208	156
140	D	D	W	5	8	143	206	158	166	D	M	W	5	7	141	200	161
141	D	L	S	5	4	141	198	151	167	F	L	W	5	7	155	197	149
142	D	L	S	5	10	142	207	154	168	D	M	S	5	3	142	196	156
143	D	M	W	5	6	134	196	152	169	F	L	R	5	5	142	190	145
144	M	M	S	6	1	141	195	146	**170**	D	D	S	5	7	151	195	157
145	D	D	S	5	8	137	194	149	171	D	M	S	5	6	145	195	150
146	R	L	S	5	7	154	204	162									

XIX.—Roxburgh District Asylum.

MALES.									MALES.								
1	M	L	W	5	4	141	190	149	26	M	M	S	5	7	141	191	152
2	M	L	W	5	4	149	198	151	27	M	M	S	5	5	138	192	139
3	M	M	S	5	7	134	196	153	28	D	D	W	6	2	147	210	163
4	D	L	S	5	5	133	194	147	29	M	L	S	5	9	134	181	145
5	M	M	S	5	5	144	198	155	**30**	D	L	S	5	6	133	201	154
6	M	L	S	5	5	134	188	148	31	M	L	W	5	3	152	198	152
7	D	D	S	5	6	147	208	162	32	F	L	W	6	0	136	193	149
8	D	D	W	5	7	138	203	149	33	M	L	S	5	6	141	193	160
9	D	M	S	5	5	138	187	149	34	D	L	W	5	10	133	200	154
10	M	L	W	5	1	126	181	147	**35**	D	L	W	5	9	137	196	147
11	M	D	S	5	5	146	193	149	36	M	L	S	5	10	144	191	151
12	M	D	R	5	6	132	193	153	37	M	D	W	5	4	126	193	148
13	D	L	S	5	8	140	193	147	38	M	L	S	5	8	140	194	150
14	M	L	S	5	7	139	193	157	39	D	M	S	5	10	136	198	156
15	D	M	S	5	5	140	193	147	**40**	D	L	S	5	1	130	188	144
16	F	L	W	5	7	140	199	155	41	D	L	S	5	7	147	203	152
17	M	L	S	5	4	137	194	152	42	F	L	S	5	9	128	192	153
18	M	M	S	5	3	134	191	144	43	M	L	S	5	0	136	196	149
19	M	L	S	5	8	136	191	144	44	M	L	S	5	10	145	200	153
20	D	L	S	5	4	134	194	150	**45**	M	L	W	5	7	138	194	148
21	M	L	S	5	2	142	188	155	46	F	L	S	5	3	137	188	139
22	D	D	S	5	3	139	188	160	47	M	L	S	5	7	138	197	146
23	D	D	S	5	7	126	187	142	48	M	L	S	5	6	140	195	152
24	D	L	S	5	6	138	184	154	49	M	L	S	5	1	141	194	150
25	D	D	S	5	6	133	183	148	**50**	M	L	S	5	11	143	199	158

XIX.—Roxburgh District Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
51	M	M	S	5	7	136	190	150	**95**	M	L	S	5	8	153	205	159
52	R	D	S	5	11	142	196	152	96	D	M	S	5	6	143	201	145
53	M	L	S	5	8	137	198	153	97	M	D	W	5	5	139	195	150
54	M	L	S	5	6	146	198	151	98	M	L	S	5	7	139	194	144
55	F	L	S	5	8	141	203	151	99	D	M	W	5	4	142	196	157
56	M	L	R	5	9	139	192	150	**100**	M	L	W	5	10	145	194	157
57	M	L	S	5	7	136	191	145	101	M	L	S	5	3	121	192	146
58	R	L	C	5	1	150	204	152	102	D	M	S	5	8	142	202	156
59	D	L	S	5	9	144	204	150	103	D	L	S	5	3	129	178	143
60	M	L	S	5	5	138	198	154	104	M	M	S	5	6	139	195	150
61	M	L	S	5	6	130	188	153	**105**	M	L	S	5	3	143	189	145
62	D	L	S	5	4	141	199	154	106	F	L	S	5	8	137	189	154
63	M	M	S	5	9	142	200	159	107	M	L	W	5	8	147	184	155
64	M	L	W	5	7	142	192	142	108	M	L	S	5	6	137	195	140
65	M	L	S	5	10	139	193	146	109	M	M	S	5	6	133	201	143
66	M	D	S	5	9	141	207	155	**110**	M	L	S	5	5	142	199	151
67	M	L	S	5	10	144	203	156	111	M	L	S	5	5	131	194	146
68	D	L	S	5	10	141	200	146	112	D	M	W	5	2	143	189	152
69	F	M	W	5	11	134	192	149	113	M	L	S	5	5	133	200	152
70	D	M	S	5	6	135	179	137	114	D	M	S	5	2	140	190	153
71	M	L	S	5	7	143	204	155	**115**	D	L	S	5	5	123	188	158
72	M	L	S	5	5	139	188	155	116	M	L	S	5	6	135	200	151
73	M	L	S	5	8	139	203	148	117	M	L	W	5	9	138	202	154
74	M	D	S	5	6	135	192	146	118	M	L	S	5	5	141	206	153
75	M	L	W	6	0	145	204	158	119	M	L	W	5	8	137	191	156
76	M	L	R	5	6	130	195	146	**120**	D	M	S	5	5	130	194	153
77	M	M	S	5	8	151	205	154	121	M	L	S	5	6	140	197	159
78	D	L	W	5	4	141	192	151	122	M	D	S	5	6	145	197	153
79	F	D	S	5	3	147	192	153	123	M	L	S	5	9	139	194	153
80	D	L	S	5	1	126	182	132	124	M	L	S	5	7	133	196	151
81	M	M	S	5	5	133	190	139	**125**	M	M	S	5	7	137	188	156
82	M	L	S	5	9	131	184	148	126	M	L	S	5	8	132	201	152
83	F	L	S	5	11	158	222	167	127	M	L	S	5	11	143	208	169
84	M	M	R	5	5	138	189	154	128	M	L	S	5	8	138	195	149
85	D	D	C	5	6	147	206	161	129	M	L	S	5	11	144	193	160
86	D	L	S	5	7	153	205	149	**130**	M	L	S	5	8	145	192	153
87	M	L	S	5	9	147	196	148	131	M	M	S	5	6	129	194	148
88	M	L	S	5	2	128	196	145	132	M	L	S	5	8	134	182	146
89	M	M	S	6	0	146	202	158	133	F	L	S	5	8	139	197	149
90	M	M	S	5	4	143	198	151	134	D	L	S	5	8	138	194	152
91	M	L	S	5	10	154	208	156	**135**	D	D	S	5	8	142	196	150
92	M	M	S	5	3	138	191	146	136	M	L	S	5	10	136	197	157
93	M	L	S	5	7	131	188	147	137	M	L	S	5	5	132	184	153
94	M	L	W	5	7	154	211	160	138	M	L	W	5	3	131	196	154

XX.—Stirling District Asylum.

MALES.									MALES.								
1	M	M	S	5	4	125	184	143	6	D	D	S	5	8	143	202	149
2	M	D	S	5	7	138	194	152	7	F	M	S	5	10	144	202	147
3	F	M	S	5	6	147	191	156	8	D	M	S	5	4	125	182	148
4	F	D	S	5	8	143	196	153	9	D	D	W	5	11	146	198	147
5	D	D	W	5	8	144	201	150	**10**	M	D	S	6	0	141	194	153

XX.—Stirling District Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
11	R	M	R	5	7	137	186	145	71	M	D	S	5	4	140	187	153
12	M	M	S	5	5	143	194	154	72	D	M	W	5	4	143	194	148
13	M	M	S	5	10	146	199	164	73	M	M	W	5	3	138	196	146
14	F	M	S	5	9	138	194	148	74	M	M	S	5	6	145	190	156
15	M	M	W	5	9	137	196	145	**75**	D	D	S	5	3	150	186	152
16	D	D	S	5	5	142	202	154	76	M	L	W	5	1	135	186	151
17	D	D	S	5	7	141	203	156	77	F	M	S	5	8	137	194	149
18	D	D	S	5	7	155	194	153	78	D	D	S	5	6	135	194	147
19	D	D	S	5	5	144	199	156	79	D	D	W	5	9	140	200	152
20	M	M	S	5	3	127	191	145	**80**	D	D	W	5	3	133	196	149
21	M	D	S	5	7	154	202	151	81	D	D	S	5	7	135	188	152
22	D	L	S	5	5	140	202	151	82	M	M	W	5	9	147	206	150
23	R	M	S	5	10	147	197	158	83	M	L	W	5	7	140	194	150
24	M	M	R	6	2	145	194	154	84	M	D	S	5	5	144	208	151
25	M	M	S	5	9	140	206	159	**85**	D	D	W	5	3	126	183	145
26	R	L	S	5	10	150	199	154	86	M	D	S	5	2	135	190	145
27	D	L	S	5	7	130	188	146	87	M	D	S	5	3	145	208	154
28	M	L	S	5	8	136	200	156	88	M	L	S	5	3	133	202	159
29	D	D	W	5	6	148	197	161	89	M	L	S	5	9	140	192	156
30	F	L	S	5	4	138	205	161	**90**	M	D	S	5	6	144	197	152
31	M	D	W	5	10	146	204	152	91	D	M	S	5	8	141	199	157
32	D	D	S	5	5	137	199	148	92	M	D	W	5	6	132	199	157
33	F	M	W	5	4	134	199	153	93	D	D	W	5	5	137	204	149
34	M	M	S	5	11	150	208	159	94	D	D	S	5	5	145	197	147
35	F	M	S	5	4	145	210	157	**95**	M	M	S	5	5	147	203	156
36	M	M	W	5	8	136	187	154	96	M	D	S	5	7	135	190	147
37	D	D	W	5	9	144	197	150	97	M	D	W	5	5	140	200	151
38	M	L	S	5	9	137	194	153	98	D	D	W	5	10	143	199	155
39	F	L	S	5	4	141	201	150	99	D	D	S	5	2	133	187	152
40	D	M	S	5	5	128	199	151	**100**	F	L	S	5	4	141	191	150
41	F	L	W	5	4	146	199	148	101	D	M	W	5	6	140	192	146
42	D	M	S	5	3	141	197	153	102	D	L	S	5	1	139	189	151
43	M	M	S	5	5	138	188	149	103	F	M	S	5	7	141	198	145
44	M	M	S	...		141	191	152	104	M	M	C	5	7	141	203	157
45	D	M	W	5	4	144	199	164	**105**	M	L	C	5	1	131	188	144
46	D	M	W	5	4	137	186	149	106	M	D	W	5	5	141	194	147
47	D	M	S	5	5	137	194	150	107	D	D	R	5	6	142	192	151
48	D	M	S	5	2	136	185	147	108	F	M	S	5	2	135	198	147
49	M	L	S	5	2	136	185	156	109	D	M	S	5	3	136	199	152
50	M	L	S	5	8	138	205	158	**110**	M	L	S	5	4	140	205	157
51	M	M	S	5	9	141	196	158	111	M	M	S	5	4	143	196	156
52	M	M	R	5	6	133	194	153	112	D	M	W	5	2	140	196	159
53	M	L	S	5	10	140	199	153	113	M	D	S	5	2	132	192	149
54	D	M	C	5	2	142	201	157	114	D	D	W	5	6	145	196	159
55	D	D	C	5	0	138	187	152	**115**	M	M	S	5	7	129	191	147
56	D	M	W	5	7	136	209	155	116	D	M	S	5	8	137	193	152
57	D	M	S	5	8	136	190	153	117	M	D	W	5	10	135	190	148
58	F	L	S	5	4	130	191	148	118	M	M	S	5	6	131	188	148
59	D	L	W	5	9	143	205	151	119	M	M	S	5	9	145	197	158
60	D	D	S	5	10	130	181	147	**120**	M	M	C	5	5	144	198	151
61	M	D	W	5	0	132	193	150	121	M	L	S	5	5	138	207	148
62	D	M	S	5	5	137	193	159	122	D	L	W	5	5	137	198	150
63	D	L	W	5	2	141	190	152	123	D	D	W	6	0	140	202	152
64	D	D	J	5	2	136	188	143	124	M	M	S	5	7	143	210	163
65	D	M	W	5	6	131	191	151	**125**	D	M	R	5	3	137	188	149
66	F	M	S	5	7	136	202	156	126	F	M	S	5	11	141	197	141
67	D	D	S	5	5	144	190	148	127	F	M	S	5	4	133	175	139
68	M	M	W	5	2	140	199	158	128	D	D	S	5	9	131	182	147
69	D	M	S	5	6	137	192	146	129	M	D	S	5	1	129	187	142
70	R	M	W	5	8	135	196	153	**130**	D	M	S	5	7	142	195	150

XX.—Stirling District Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
131	M	M	S	5	5	134	196	156	191	M	M	W	5	8	145	198	154
132	D	D	W	5	9	141	193	151	192	M	L	S	5	6	138	191	148
133	M	M	S	5	6	134	186	147	193	D	L	S	5	4	144	192	142
134	M	D	S	5	5	135	191	141	194	D	L	W	5	0	135	195	153
135	F	L	S	5	2	128	191	141	**195**	...	D	C	5	1	134	202	135
136	D	D	S	5	3	141	203	152	196	M	M	S	5	2	135	193	142
137	D	D	R	5	3	129	199	144	197	M	M	S	5	2	134	194	141
138	M	D	S	5	5	135	193	155	198	M	L	S	5	9	137	199	155
139	F	L	S	5	3	138	198	152	199	D	D	S	5	6	146	210	156
140	D	M	S	5	3	141	191	147	**200**	D	M	S	5	3	136	188	154
141	D	L	R	5	6	145	198	147	201	D	L	S	5	2	133	201	149
142	D	L	S	5	3	139	197	149	202	D	D	W	5	4	141	186	149
143	M	L	S	5	5	130	190	146	203	M	M	S	5	3	139	190	145
144	D	L	W	5	3	139	188	146	204	D	D	S	5	10	136	193	147
145	D	M	S	5	7	144	212	153	**205**	D	L	S	5	2	138	200	147
146	M	L	W	5	11	153	191	159	206	D	M	W	6	1	149	206	158
147	M	L	S	5	6	136	197	150	207	D	L	S	5	5	140	205	152
148	M	L	W	5	7	137	205	157	208	F	L	S	5	4	143	194	155
149	D	M	W	5	4	143	192	149	209	M	L	S	5	5	134	189	154
150	D	L	W	5	4	137	201	155	**210**	D	L	S	5	3	127	193	146
151	L	L	S	5	8	141	192	152	211	M	M	S	5	4	140	200	155
152	M	L	W	5	4	142	193	152	212	...	L	W	5	7	142	195	159
153	M	L	S	5	5	153	196	151	213	D	M	W	5	1	137	197	151
154	D	D	S	5	7	134	188	160	214	M	M	S	5	0	138	198	144
155	F	L	W	5	8	140	193	156	**215**	R	D	W	5	0	142	196	146
156	D	L	S	5	9	135	193	146	216	M	M	S	5	7	137	194	147
157	D	D	R	5	8	140	198	155	217	D	M	W	5	3	131	202	147
158	M	L	S	5	9	135	196	150	218	M	L	S	5	4	136	194	153
159	M	L	W	5	2	138	198	157	219	D	L	R	5	5	143	203	167
160	D	D	S	5	6	142	194	152	**220**	M	L	S	5	3	141	200	151
161	D	D	S	5	7	152	209	155	221	M	L	S	5	4	138	197	155
162	D	D	R	5	3	130	199	143	222	D	L	S	5	9	139	195	152
163	D	L	S	5	8	128	184	148	223	M	L	S	5	5	132	199	146
164	M	L	S	5	7	133	198	156	224	...	D	S	5	5	138	190	151
165	M	D	S	5	3	141	203	162	**225**	D	L	S	5	10	146	201	153
166	D	M	W	5	0	142	185	149	226	D	L	S	5	2	135	198	154
167	D	M	S	5	4	132	190	152	227	L	L	W	5	2	140	172	142
168	M	L	S	5	6	144	198	148	228	M	L	S	5	6	130	191	147
169	D	D	S	5	10	142	194	156	229	F	L	S	5	1	144	195	145
170	M	L	S	5	9	135	193	142	**230**	M	L	W	5	4	141	198	149
171	D	D	S	5	7	150	202	149	231	F	L	S	5	4	142	190	144
172	F	M	S	5	10	146	201	143	232	M	M	W	5	3	140	198	151
173	F	L	W	5	7	144	204	151	233	D	L	S	5	4	143	210	155
174	F	L	C	5	4	137	198	149	234	D	M	S	4	11	128	182	145
175	D	M	W	5	7	143	190	145	**235**	D	L	S	5	7	150	197	146
176	D	D	W	5	5	147	200	150	236	D	L	S	5	4	141	193	147
177	M	L	S	5	7	134	181	152	237	D	...	S	5	6	128	194	154
178	M	L	S	5	7	142	192	148	238	M	L	W	4	10	142	192	155
179	D	D	S	5	6	149	202	159	239	D	M	S	5	6	136	194	151
180	D	M	S	5	5	141	200	157	**240**	D	...	S	5	4	135	192	143
181	D	M	S	5	6	142	208	165	241	M	L	S	4	10	132	175	134
182	D	M	S	5	9	147	204	158	242	D	D	C	5	4	148	191	147
183	D	L	S	5	5	133	205	155	243	D	D	R	5	7	153	196	154
184	M	L	S	5	10	137	200	149	244	F	L	C	5	5	147	207	149
185	M	M	W	5	11	147	196	155	**245**	D	M	S	5	4	147	196	156
186	M	L	R	5	6	149	205	155	246	D	M	W	5	1	126	184	140
187	M	L	S	5	6	135	198	148	247	D	D	W	5	4	139	193	156
188	M	M	S	5	6	141	192	147	248	M	D	S	5	10	158	205	158
189	D	L	S	5	5	150	203	154	249	D	D	S	5	2	154	206	172
190	D	L	S	5	2	144	193	148	**250**	D	D	S	5	7	153	200	156

XX.—Stirling District Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
251	D	L	W	5	6	140	191	147	282	D	D	R	5	5	143	202	148
252	D	L	S	5	5	143	199	140	283	M	D	S	5	6	137	189	144
253	D	D	S	5	6	140	194	151	284	M	L	W	5	8	148	194	148
254	D	L	S	5	5	130	197	150	**285**	D	L	S	5	4	142	208	155
255	D	L	S	5	4	139	202	155	286	M	M	W	5	7	141	196	154
256	D	D	S	5	2	137	196	145	287	D	D	S	5	7	136	197	150
257	M	D	S	5	4	135	194	158	288	D	L	S	5	7	142	178	151
258	D	M	S	5	6	149	203	151	289	R	D	S	5	4	134	186	142
259	M	L	S	5	7	149	190	145	**290**	M	L	S	5	8	146	195	158
260	D	D	S	5	7	140	196	149	291	M	L	S	5	4	131	192	150
261	M	L	S	5	7	148	201	141	292	M	M	C	5	5	124	188	164
262	M	L	R	5	9	139	190	146	293	D	M	S	5	5	140	181	161
263	M	L	W	6	0	152	197	155	294	D	M	S	5	1	144	198	155
264	M	D	S	5	4	137	199	156	**295**	D	L	S	5	5	134	191	145
265	R	L	S	5	7	144	193	155	296	D	L	S	5	5	136	195	149
266	M	L	S	5	7	146	195	143	297	M	L	W	5	8	135	195	148
267	D	L	S	5	3	134	187	146	298	M	L	S	5	7	131	186	143
268	M	L	S	5	8	136	191	157	299	F	M	S	5	4	147	195	148
269	F	M	W	5	5	135	184	144	**300**	M	L	S	5	6	130	185	143
270	M	L	S	5	4	141	198	158	301	D	L	S	5	4	153	198	145
271	M	D	S	5	4	136	194	148	302	M	L	S	5	7	135	199	158
272	M	M	S	5	7	137	197	143	303	D	D	S	5	7	137	189	142
273	D	L	S	5	8	135	197	154	304	M	L	W	5	7	146	204	147
274	D	M	S	5	6	145	188	154	**305**	M	L	S	5	7	147	198	159
275	R	L	S	5	7	138	198	155	306	D	D	S	5	5	137	191	150
276	D	D	S	5	4	142	196	156	307	D	L	W	5	5	135	198	147
277	D	D	W	5	3	141	196	144	308	D	L	S	5	6	146	205	157
278	M	L	W	5	10	134	189	149	309	D	L	S	5	7	140	188	147
279	M	M	S	5	5	141	192	152	**310**	M	L	R	5	5	148	203	155
280	D	M	S	5	8	140	187	156	311	D	L	C	5	9	135	193	140
281	D	L	S	5	8	146	200	149									

XXI.—Greenock Parochial Asylum.

MALES.									MALES.								
1	M	M	W	5	8	128	201	143	21	M	D	S	5	10	138	198	152
2	M	D	S	5	2	122	178	134	22	D	M	S	5	2	127	183	148
3	D	L	S	5	5	133	195	149	23	D	L	W	5	10	130	199	156
4	M	L	S	5	9	135	192	144	24	M	M	S	5	8	132	200	149
5	M	L	S	5	2	123	195	146	**25**	D	D	S	5	2	129	192	152
6	M	M	S	4	9	130	183	151	26	M	L	W	5	8	128	197	147
7	M	L	W	5	5	128	198	154	27	D	M	S	5	8	135	205	157
8	M	L	S	5	3	126	187	146	28	M	M	S	5	7	134	204	147
9	M	L	W	5	5	133	188	147	29	M	D	S	5	2	131	184	148
10	M	D	S	5	2	143	204	162	**30**	M	L	W	5	7	131	187	140
11	M	L	S	5	1	136	194	155	31	M	L	S	5	0	129	186	141
12	M	M	S	5	6	135	198	151	32	M	L	W	5	7	131	203	148
13	M	L	W	5	7	130	191	153	33	M	M	S	5	1	134	188	146
14	M	L	S	5	7	139	205	158	34	M	L	S	5	8	132	192	144
15	M	L	S	5	5	138	187	151	**35**	M	L	S	5	4	135	194	146
16	M	D	S	5	9	135	194	154	36	M	D	S	5	2	124	193	143
17	M	L	S	5	9	133	200	154	37	D	L	S	5	4	129	184	151
18	R	L	S	5	3	130	185	142	38	D	L	W	5	2	138	181	146
19	M	L	S	5	11	137	200	151	39	M	D	S	5	6	133	194	143
20	D	L	S	6	1	141	209	157	**40**	D	L	S	5	8	134	205	148

XXI.—Greenock Parochial Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
41	M	L	S	5	8	138	197	151	81	D	L	S	5	0	126	189	138
42	D	L	S	6	0	139	199	152	82	D	M	S	5	7	134	191	149
43	M	D	S	5	1	128	186	153	83	D	D	S	5	5	133	188	147
44	M	L	W	5	4	131	195	153	84	M	M	S	6	1	143	211	164
45	M	D	S	5	6	141	200	156	**85**	M	L	W	5	5	137	198	143
46	M	D	S	5	5	136	195	155	86	M	M	S	5	2	129	183	132
47	M	L	S	5	5	135	190	149	87	M	L	W	5	8	134	201	150
48	D	D	S	5	7	141	193	154	88	M	L	S	5	5	130	189	153
49	D	D	W	5	4	138	198	152	89	M	M	S	5	8	134	195	145
50	D	D	S	5	6	138	194	150	**90**	M	L	W	5	9	140	203	160
51	M	M	W	5	8	132	195	158	91	M	M	W	5	6	134	210	156
52	M	M	S	5	3	142	191	160	92	M	D	S	5	5	132	197	154
53	M	L	S	5	3	130	188	144	93	M	L	S	5	7	132	199	150
54	M	L	S	5	7	130	204	153	94	M	D	S	5	0	132	188	144
55	M	L	S	5	2	128	190	148	**95**	M	M	S	5	7	139	195	160
56	M	M	S	5	5	135	201	157	96	D	D	S	5	6	129	195	153
57	M	M	S	5	7	136	202	161	97	M	L	S	5	4	128	192	142
58	M	L	W	5	6	138	195	152	98	M	L	R	5	8	131	201	163
59	M	M	W	5	8	137	199	160	99	M	M	S	5	5	136	197	158
60	D	L	W	5	6	128	191	145	**100**	M	L	S	5	3	133	193	144
61	M	L	R	5	7	130	200	148	101	M	L	S	5	8	134	191	144
62	M	M	S	5	6	123	188	147	102	M	L	W	5	8	136	198	158
63	D	M	S	5	3	124	193	151	103	M	L	S	5	10	137	203	151
64	D	M	S	5	2	149	207	154	104	M	M	S	5	8	143	207	148
65	M	L	S	5	7	137	194	151	**105**	M	M	S	5	11	137	202	151
66	M	L	S	5	8	134	197	156	106	D	M	S	5	4	138	196	158
67	M	M	S	5	5	133	190	153	107	M	M	S	5	1	136	196	154
68	D	M	S	5	8	135	203	160	108	D	L	S	5	3	135	189	148
69	M	D	S	5	4	134	200	156	109	M	L	S	5	1	133	185	135
70	M	D	S	5	7	138	199	151	**110**	D	L	S	5	7	132	203	153
71	M	M	S	5	2	135	199	148	111	M	L	S	5	7	139	205	160
72	M	L	S	5	6	128	191	148	112	M	D	S	5	4	137	195	151
73	M	L	S	5	6	135	195	147	113	D	L	S	5	3	134	187	145
74	M	D	R	5	6	133	199	150	114	M	L	S	5	6	132	200	154
75	M	L	S	5	8	134	200	155	**115**	M	L	S	5	7	140	194	153
76	M	L	S	5	5	130	193	151	116	D	D	S	4	10	127	175	145
77	D	L	W	5	3	132	198	151	117	M	M	S	5	4	137	195	156
78	D	L	W	6	1	135	188	150	118	M	L	S	5	9	136	204	163
79	D	...	S	5	5	129	199	147	119	M	M	S	6	0	138	198	160
80	M	M	W	5	7	134	202	158									

XXII.—Paisley Parochial Asylum.

MALES.									MALES.								
1	M	L	S	5	6	135	201	148	11	M	L	S	5	2	132	193	153
2	M	L	S	5	7	139	209	153	12	D	D	S	5	5	142	200	152
3	D	D	S	5	9	136	203	150	13	D	L	S	5	0	137	191	145
4	M	M	S	5	7	139	199	153	14	R	L	S	5	2	139	199	145
5	M	M	S	5	9	146	194	146	**15**	R	L	S	5	5	134	186	144
6	M	L	S	5	8	144	197	154	16	M	L	S	5	4	142	192	162
7	D	D	S	6	0	153	209	159	17	M	L	S	5	5	135	195	150
8	D	M	S	5	5	141	200	151	18	M	L	S	5	6	138	206	154
9	D	M	S	5	0	137	189	151	19	M	M	W	5	4	144	195	151
10	M	M	S	5	6	137	194	152	**20**	M	L	S	5	10	152	193	153

XXII.—Paisley Parochial Asylum.

MALES.									MALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
21	M	M	W	5	6	147	199	152	58	M	L	W	5	8	137	203	152
22	M	M	S	4	11	133	182	141	59	M	M	S	5	2	141	209	158
23	M	M	S	5	5	135	194	158	**60**	M	L	S	5	7	137	197	150
24	M	L	S	5	2	128	178	145	61	M	L	S	5	8	135	194	148
25	D	M	S	5	2	137	192	156	62	M	M	S	5	5	138	200	145
26	D	D	S	5	6	137	190	158	63	M	D	S	5	8	134	196	149
27	M	M	S	5	10	144	213	158	64	D	M	S	5	7	137	201	164
28	M	M	S	5	0	133	196	150	**65**	D	M	S	5	7	133	197	149
29	M	M	S	5	7	141	203	161	66	D	L	W	5	10	137	200	148
30	M	L	S	5	3	138	201	152	67	D	L	S	5	7	135	203	150
31	M	M	S	5	4	136	196	149	68	M	L	S	5	3	134	191	153
32	M	D	S	5	6	135	196	147	69	M	L	S	5	5	132	195	156
33	M	L	S	5	3	133	189	146	**70**	M	L	S	5	10	141	204	152
34	D	D	R	5	4	136	188	149	71	M	L	S	5	4	141	202	158
35	M	L	S	5	0	133	186	142	72	M	L	S	5	8	141	199	156
36	M	L	S	5	8	135	192	147	73	M	L	S	5	7	140	195	145
37	M	L	S	5	2	134	194	153	74	D	L	S	5	10	141	197	149
38	D	L	S	5	7	138	200	153	**75**	D	D	S	5	4	136	194	156
39	M	L	S	5	3	136	197	152	76	M	L	S	5	7	139	203	150
40	M	M	S	4	10	130	190	140	77	M	D	S	5	11	142	200	151
41	M	L	S	5	5	132	196	152	78	M	L	S	5	4	138	192	151
42	M	M	S	5	6	134	202	157	79	M	D	S	5	10	134	199	157
43	M	L	S	5	8	134	195	153	**80**	M	L	S	5	6	137	189	148
44	M	L	S	5	7	133	190	154	81	D	D	S	5	2	133	188	147
45	M	M	S	5	4	129	208	148	82	M	L	S	4	10	143	205	154
46	M	L	S	5	3	139	194	148	83	M	L	S	5	0	128	186	150
47	M	M	S	5	3	135	188	146	84	M	L	S	5	11	130	193	152
48	M	L	S	5	9	138	216	154	**85**	M	D	S	5	5	130	198	147
49	M	M	W	5	4	138	192	148	86	D	D	S	5	8	134	209	157
50	M	L	S	5	8	138	195	153	87	M	M	C	5	5	142	195	154
51	M	D	S	5	7	137	196	150	88	M	L	S	5	9	144	195	151
52	M	L	R	5	6	132	188	141	89	M	D	S	5	8	141	203	156
53	M	D	S	5	9	137	202	154	**90**	M	M	S	5	5	137	196	150
54	M	L	W	5	7	139	200	146	91	M	D	S	5	9	137	186	151
55	M	L	S	5	7	141	208	152	92	M	L	S	5	2	143	208	153
56	M	M	W	5	7	138	197	149	93	M	M	S	5	8	136	193	146
57	M	M	S	5	4	141	188	147									

I.—Aberdeen Royal Asylum.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.				H.	L.	B.		Hair.	Eyes.				H.	L.	B.
				ft.	in.	mm.	mm.	mm.					ft.	in.	mm.	mm.	mm.
1	D	D	S	5	2	132	180	141	61	M	L	S	5	1	120	179	142
2	D	D	S	5	6	134	187	143	62	M	M	S	4	10	128	183	143
3	R	L	S	5	2	131	187	146	63	R	D	S	5	3	130	182	145
4	D	M	C	5	1	134	187	152	64	D	D	S	5	2	128	187	142
5	...	L	S	4	10	130	187	147	**65**	R	D	S	5	3	132	186	150
6	R	M	C	5	2	140	183	141	66	...	L	S	5	3	132	180	143
7	D	M	W	5	1	136	171	142	67	D	D	J	5	1	127	181	143
8	D	D	S	5	3	132	187	146	68	M	L	S	5	0	127	181	147
9	D	D	S	5	1	133	182	141	69	...	M	S	4	10	120	182	144
10	D	D	C	...		141	194	154	**70**	...	M	S	4	10	124	178	138
11	D	D	S	5	5	132	188	148	71	D	M	S	4	11	132	194	144
12	M	M	W	5	2	132	178	136	72	...	L	S	5	0	137	179	145
13	M	M	S	5	1	132	178	139	73	D	M	S	5	7	139	193	150
14	D	D	S	5	2	139	193	146	74	D	L	S	5	3	149	193	148
15	M	D	R	5	3	129	194	144	**75**	D	M	S	5	1	129	187	146
16	D	D	C	5	3	136	183	147	76	F	M	S	5	5	140	194	147
17	D	...	W	5	0	133	167	142	77	F	M	S	4	10	131	185	149
18	D	...	S	5	3	133	186	141	78	M	M	S	5	3	140	197	150
19	...	D	W	5	1	139	191	153	79	...	L	S	5	1	125	184	145
20	M	D	C	5	2	137	186	153	**80**	D	M	S	5	0	128	183	148
21	...	L	S	4	7	126	188	144	81	D	M	S	5	2	129	201	146
22	...	L	C	5	3	131	194	151	82	D	M	S	5	3	139	179	150
23	...	L	S	4	7	130	184	141	83	D	D	S	4	9	138	176	145
24	...	M	S	4	9	123	171	135	84	D	M	S	5	1	131	190	143
25	...	L	S	5	0	133	187	153	**85**	F	L	S	4	3	130	179	139
26	...	L	S	5	1	131	187	149	86	D	M	S	4	11	131	192	154
27	...	D	S	4	10	128	188	141	87	D	M	W	5	4	135	190	143
28	D	M	S	5	2	135	189	153	88	M	M	S	5	5	133	188	152
29	R	L	C	4	10	132	189	149	89	M	D	S	4	5	124	182	137
30	D	D	W	4	10	120	186	146	**90**	D	M	S	5	2	128	189	150
31	R	M	S	5	2	123	171	141	91	...	D	W	5	2	119	184	139
32	...	L	S	4	10	132	188	144	92	D	M	S	4	10	127	191	149
33	...	D	C	...		127	181	150	93	D	D	S	5	1	128	177	146
34	...	L	S	4	11	139	186	149	94	D	M	S	4	11	138	187	138
35	D	L	S	4	7	127	176	142	**95**	D	L	W	5	3	132	182	148
36	D	M	S	5	0	131	179	147	96	D	D	W	...		119	169	130
37	D	D	S	5	3	140	186	149	97	...	L	S	5	0	138	188	147
38	D	L	C	5	1	122	186	141	98	F	L	W	5	1	123	177	139
39	D	D	S	5	2	133	186	145	99	D	M	S	5	6	135	186	157
40	D	D	S	5	2	131	187	147	**100**	M	M	S	5	0	126	186	151
41	D	D	S	5	0	119	168	139	101	M	L	S	5	2	123	182	147
42	...	L	S	4	10	148	198	166	102	M	M	C	5	2	133	176	148
43	R	M	C	5	1	134	188	147	103	D	D	S	5	5	132	184	147
44	D	M	S	5	2	141	187	150	104	M	L	S	4	11	135	191	150
45	D	D	S	5	2	134	183	145	**105**	R	L	C	5	0	125	176	138
46	M	M	S	4	11	134	188	152	106	D	D	S	5	1	136	183	152
47	...	L	R	5	3	125	169	143	107	...	L	S	5	1	130	188	155
48	D	D	W	5	7	138	190	139	108	D	M	W	5	4	139	194	152
49	...	M	S	5	1	135	201	154	109	D	D	S	5	3	128	180	145
50	D	M	S	5	2	126	194	148	**110**	...	M	S	5	1	120	179	139
51	...	D	S	5	0	123	190	144	111	M	M	S	5	1	135	190	153
52	D	D	S	4	7	125	179	139	112	D	D	S	5	4	152	207	178
53	..	L	S	5	3	131	191	153	113	D	D	S	5	0	126	187	148
54	M	M	S	5	3	139	183	148	114	D	M	S	4	10	134	184	147
55	D	D	S	5	3	124	188	148	**115**	D	M	C	5	2	134	186	145
56	M	D	S	5	2	132	170	134	116	M	L	S	5	2	135	195	144
57	D	L	S	5	3	130	192	144	117	D	L	S	5	0	139	184	147
58	M	M	S	5	3	126	186	151	118	D	M	S	5	4	126	187	154
59	M	M	S	5	0	130	183	145	119	M	M	C	4	11	130	187	144
60	D	L	S	5	3	138	193	145	**120**	F	L	S	5	4	130	182	135

I.—Aberdeen Royal Asylum.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
121	...	M	S	5	0	128	187	148	181	M	M	S	4	11	131	187	154
122	...	M	S	5	5	133	199	162	182	R	L	S	5	5	141	197	153
123	...	M	S	5	2	126	189	130	183	R	M	S	4	11	138	188	142
124	D	L	S	5	1	139	181	148	184	D	D	C	5	1	138	189	151
125	D	L	S	5	6	140	202	151	**185**	M	L	S	5	1	131	184	141
126	...	L	S	5	0	150	180	143	186	D	M	S	5	2	132	183	145
127	M	M	S	5	0	125	187	150	187	D	M	S	5	4	125	185	142
128	D	M	W	5	0	128	190	140	188	...	M	S	4	8	128	189	148
129	F	L	C	5	0	138	183	150	189	D	M	S	5	5	128	188	145
130	D	D	S	4	10	136	179	145	**190**	D	M	S	5	2	134	181	144
131	...	D	S	4	11	138	187	143	191	...	D	S	5	0	145	186	148
132	D	D	S	5	2	121	183	141	192	...	M	S	5	2	134	184	152
133	...	M	S	5	2	126	175	147	193	D	M	S	5	3	137	192	150
134	...	M	S	5	3	129	187	142	194	D	M	S	5	2	138	183	140
135	R	L	S	5	2	132	180	140	**195**	F	M	S	5	4	138	191	149
136	...	D	S	5	1	140	197	152	196	D	D	S	5	2	130	190	146
137	D	M	S	4	5	139	184	152	197	D	M	S	5	2	126	181	140
138	...	M	S	5	3	138	189	146	198	D	M	S	5	5	121	189	146
139	D	D	S	5	2	134	184	144	199	...	M	S	4	11	128	186	145
140	...	M	S	5	1	137	193	152	**200**	...	M	S	5	3	139	200	152
141	...	D	S	5	0	122	187	146	201	F	M	S	5	3	133	192	147
142	D	M	C	4	10	132	183	149	202	D	D	S	5	0	127	180	139
143	D	D	C	4	1	133	173	143	203	M	M	S	5	4	125	185	133
144	R	M	C	5	0	126	172	147	204	...	M	S	5	6	138	193	151
145	D	D	C	4	7	128	178	133	**205**	R	L	S	4	11	145	193	152
146	...	L	S	5	1	132	187	146	206	D	D	S	4	11	127	191	149
147	...	L	S	4	10	125	198	154	207	D	M	S	5	3	137	199	150
148	...	L	S	4	8	125	193	143	208	D	M	C	5	1	126	183	145
149	...	M	S	5	1	123	182	146	209	D	M	S	5	5	129	183	143
150	...	M	S	5	2	130	184	148	**210**	D	D	C	5	3	134	189	147
151	...	M	S	5	0	138	190	148	211	D	D	W	5	8	128	192	151
152	D	M	S	4	10	129	183	137	212	...	...	...	5	0	134	198	157
153	M	D	S	4	11	140	194	145	213	M	L	S	5	4	129	184	151
154	D	M	S	5	2	147	191	150	214	D	D	W	5	2	125	190	145
155	...	M	S	5	0	127	179	149	**215**	...	M	S	5	0	129	179	142
156	...	M	W	...		125	188	145	216	M	L	S	5	1	126	184	145
157	D	D	S	..		140	199	152	217	D	D	C	5	3	123	184	145
158	D	D	S	5	7	139	186	143	218	D	L	S	4	11	128	184	138
159	...	M	S	5	4	148	194	146	219	D	D	S	4	10	137	185	146
160	...	D	S	5	4	132	187	141	**220**	D	L	S	4	11	132	191	132
161	D	D	S	4	11	132	181	140	221	...	L	S	5	2	120	177	145
162	D	M	C	5	2	134	189	143	222	...	M	S	5	6	123	178	137
163	...	M	S	5	0	128	185	142	223	D	L	S	5	4	130	178	141
164	...	M	S	5	3	132	185	150	224	D	D	S	5	1	126	180	143
165	M	M	S	5	1	133	191	143	**225**	...	M	C	5	2	125	190	152
166	D	M	W	5	4	133	180	141	226	D	M	S	5	1	130	186	152
167	R	M	S	5	3	144	185	142	227	M	M	S	5	2	131	185	155
168	D	M	S	5	1	144	185	145	228	D	D	S	5	3	128	183	143
169	D	D	S	5	3	134	186	144	229	D	M	S	5	3	137	187	149
170	R	M	C	5	1	147	175	149	**230**	D	D	C	5	3	121	181	143
171	D	M	S	5	2	138	182	150	231	D	M	S	5	2	127	175	146
172	M	M	S	5	3	137	186	139	232	D	L	S	4	11	121	185	139
173	...	L	S	4	10	130	176	143	233	D	M	C	4	11	128	183	149
174	M	M	S	5	2	126	180	149	234	M	M	S	5	1	132	195	151
175	M	D	S	4	11	125	169	143	**235**	M	M	S	5	3	137	198	151
176	...	D	S	5	4	133	183	144	236	D	D	S	5	0	127	186	141
177	D	M	S	4	11	132	189	150	237	D	M	S	5	2	121	180	145
178	D	M	S	5	2	128	173	146	238	M	L	S	5	0	121	185	143
179	M	L	S	5	5	137	188	147	239	D	D	C	5	3	131	178	147
180	M	M	S	5	0	133	189	143	**240**	D	D	S	5	2	130	190	145

I.—Aberdeen Royal Asylum.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
241	D	D	S	5	4	133	182	145	269	R	M	S	5	1	134	192	147
242	D	M	S	5	4	126	185	146	**270**	D	M	S	5	4	133	176	143
243	M	M	S	5	1	132	186	145	271	D	M	C	5	0	126	190	148
244	D	M	S	5	1	125	188	142	272	R	M	S	5	4	126	189	151
245	...	M	S	5	3	135	190	149	273	D	D	S	4	9	126	172	144
246	...	M	S	5	0	126	196	150	274	D	M	C	4	10	122	187	145
247	...	M	S	4	10	120	183	143	**275**	R	M	S	5	2	126	172	140
248	M	M	S	5	2	123	182	145	276	...	L	S	5	1	127	194	146
249	M	M	S	5	3	132	192	150	277	D	D	S	5	6	130	200	158
250	D	M	S	4	10	123	183	138	278	D	D	S	5	4	133	184	135
251	D	M	S	4	10	120	189	141	279	...	M	S	4	10	119	189	144
252	D	M	S	4	8	125	183	141	**280**	D	D	S	5	0	136	193	150
253	D	M	W	5	1	135	199	150	281	D	L	S	5	1	126	183	146
254	D	M	S	4	11	119	174	136	282	...	M	S	5	0	129	180	143
255	D	D	S	5	6	126	189	151	283	...	M	S	5	3	128	181	145
256	R	M	S	5	4	132	185	146	284	R	L	S	5	0	148	184	148
257	D	D	S	5	1	124	178	145	**285**	...	D	S	5	1	136	190	148
258	R	L	S	5	4	125	180	142	286	M	M	S	4	10	132	184	147
259	D	D	S	5	4	138	186	142	287	D	M	C	5	3	125	178	143
260	...	M	S	5	1	133	177	143	288	D	M	S	5	1	126	190	153
261	D	M	S	5	1	135	196	147	289	...	D	S	5	1	134	189	145
262	...	D	S	5	0	132	190	149	**290**	...	M	S	5	3	128	194	145
263	...	L	C	5	3	139	188	149	291	D	M	S	5	1	126	178	148
264	...	M	S	5	5	143	184	147	292	D	D	S	5	1	133	202	149
265	D	M	S	5	0	119	191	147	293	D	M	S	5	4	126	194	154
266	M	M	S	5	2	136	187	152	294	D	M	C	5	2	126	179	146
267	...	M	S	5	1	132	186	150	**295**	..	M	C	5	2	132	201	148
268	M	M	S	5	5	129	185	150	296	R	M	S	5	4	132	183	150

II.—Crichton Royal Institution.

FEMALES.									FEMALES.								
1	M	L	S	5	2	131	190	144	26	M	L	S	5	4	134	199	147
2	M	L	S	4	9	131	190	139	27	M	D	S	5	0	129	180	141
3	M	L	S	5	1	127	187	146	28	M	L	S	5	7	133	192	149
4	D	D	S	5	0	129	186	150	29	M	L	S	4	11	124	186	146
5	M	M	W	5	0	124	185	143	**30**	M	L	S	4	11	129	192	146
6	M	L	S	5	0	131	177	143	31	D	L	S	5	2	129	192	149
7	M	L	S	5	1	129	188	150	32	M	L	S	5	0	132	185	149
8	M	D	S	4	7	127	190	149	33	M	L	S	4	9	124	179	147
9	M	M	C	5	3	129	188	149	34	M	L	S	5	2	130	178	151
10	D	D	S	5	2	132	196	151	**35**	D	D	S	5	0	128	179	139
11	M	M	S	5	2	131	196	139	36	M	L	S	5	4	132	186	144
12	M	D	S	5	7	129	189	146	37	M	L	S	5	1	135	182	141
13	M	L	S	5	1	120	185	144	38	M	L	S	5	2	124	177	141
14	M	L	S	5	1	131	186	148	39	M	M	S	5	2	132	185	152
15	M	L	S	4	10	134	193	152	**40**	D	M	W	5	1	130	183	144
16	F	M	S	5	7	127	198	150	41	M	L	S	5	4	124	189	143
17	M	M	S	5	5	131	185	150	42	M	L	S	5	3	131	193	148
18	M	D	S	5	2	129	188	141	43	M	L	C	4	8	128	183	146
19	M	L	S	5	2	135	190	149	44	M	D	S	5	0	137	193	156
20	F	L	S	5	3	130	189	143	**45**	M	L	C	5	4	131	187	151
21	M	D	S	5	0	129	186	152	46	M	M	S	5	4	129	178	148
22	M	M	S	5	3	124	190	147	47	M	D	S	4	11	128	181	140
23	M	M	W	5	4	129	181	140	48	D	D	C	5	1	123	182	141
24	M	L	S	5	2	134	192	148	49	D	L	S	5	0	129	185	144
25	M	D	S	5	0	129	192	144	**50**	M	D	S	4	8	124	177	135

II.—Crichton Royal Institution.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
51	M	L	S	5	3	128	200	148	98	M	L	S	5	6	130	181	148
52	M	D	S	4	11	128	198	150	99	M	L	S	5	1	126	181	144
53	M	L	S	5	1	126	190	141	**100**	M	L	S	5	3	123	175	137
54	D	D	C	5	3	124	197	152	101	D	L	W	5	2	131	185	141
55	M	L	S	5	1	124	189	142	102	M	L	S	4	10	132	185	140
56	D	D	S	5	5	139	188	145	103	M	L	S	5	1	131	188	151
57	D	M	S	5	3	126	188	146	104	M	M	S	5	1	129	190	140
58	M	L	S	5	2	131	188	146	**105**	D	M	S	5	3	136	183	148
59	D	D	S	5	4	136	196	152	106	M	M	S	5	1	133	178	148
60	D	D	C	5	3	132	186	146	107	M	L	S	5	4	129	195	146
61	D	D	S	5	6	130	196	143	108	R	M	W	5	2	128	183	146
62	M	L	S	4	11	128	190	147	109	D	L	S	5	0	133	188	153
63	F	L	W	5	0	126	182	140	**110**	M	L	S	5	4	129	193	150
64	M	L	S	5	2	125	191	141	111	M	M	S	5	4	126	185	150
65	M	M	S	5	4	128	186	143	112	M	M	S	5	3	129	187	150
66	M	M	R	5	4	128	185	149	113	F	M	S	5	3	134	204	157
67	M	L	S	5	2	127	187	146	114	M	D	S	5	1	133	189	148
68	M	D	S	5	6	130	191	148	**115**	M	L	S	5	5	133	181	147
69	D	L	S	5	5	130	191	146	116	F	L	S	5	1	131	175	132
70	M	D	S	4	11	127	186	147	117	D	D	S	5	4	127	180	142
71	M	L	S	5	2	126	186	142	118	M	L	S	4	11	136	188	150
72	D	D	S	5	0	125	188	142	119	M	L	S	5	0	124	180	139
73	M	L	S	4	11	135	193	154	**120**	D	M	S	5	2	123	178	139
74	M	L	W	4	9	138	180	150	121	M	D	S	5	0	131	200	144
75	M	L	S	5	0	132	183	146	122	D	L	S	4	11	125	175	139
76	M	L	S	5	6	136	202	153	123	M	M	W	5	2	121	184	139
77	D	L	S	5	3	139	205	152	124	D	L	S	5	3	131	180	144
78	M	M	S	5	3	132	192	153	**125**	M	M	S	5	3	136	194	144
79	M	L	S	4	9	127	191	147	126	M	L	S	5	1	127	180	133
80	M	L	S	5	2	132	194	152	127	M	L	S	5	0	125	181	143
81	D	M	S	4	11	130	184	144	128	M	L	W	5	1	127	190	133
82	M	M	S	5	5	133	184	151	129	M	M	S	4	10	125	180	142
83	D	D	S	5	1	129	183	133	**130**	M	L	S	4	10	127	191	136
84	M	M	S	5	7	129	184	150	131	M	L	S	5	0	125	188	147
85	D	D	S	5	2	128	187	142	132	M	L	S	5	2	126	185	145
86	D	D	S	5	2	125	185	141	133	M	L	S	5	1	126	193	144
87	M	L	S	5	2	124	182	143	134	M	L	S	4	10	132	182	144
88	M	L	S	5	2	126	191	146	**135**	M	M	C	5	1	139	178	142
89	F	L	S	5	1	121	183	129	136	M	M	S	5	0	127	175	141
90	M	L	S	5	5	121	189	147	137	M	L	S	4	11	124	180	134
91	M	L	S	4	10	126	193	149	138	M	L	S	5	2	140	187	143
92	M	M	S	5	1	129	194	148	139	M	M	S	4	10	127	184	152
93	M	D	S	5	4	136	186	154	**140**	M	M	W	4	10	129	182	153
94	M	L	S	5	0	132	190	150	141	M	L	S	5	3	132	193	151
95	M	L	S	5	1	125	189	142	142	M	M	S	5	3	129	188	144
96	D	D	S	5	0	122	184	143	143	D	L	S	4	11	130	181	144
97	D	M	S	4	10	122	187	142	144	M	L	S	5	6	134	186	148

III.—Dundee District Asylum.

FEMALES.									FEMALES.								
1	D	D	S	6	0	129	191	153	6	M	M	S	4	11	131	187	148
2	D	L	S	5	3	138	188	141	7	M	D	R	5	5	131	188	153
3	M	D	S	5	0	133	184	141	8	M	L	S	5	1	136	186	140
4	M	L	J	4	11	126	183	147	9	D	L	S	5	2	133	195	146
5	M	M	S	5	0	124	183	135	**10**	D	D	S	4	11	123	187	141

III.—Dundee District Asylum.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
11	M	D	S	5	4	134	191	153	71	D	L	C	5	1	129	182	136
12	D	D	S	5	1	136	192	144	72	M	L	S	5	3	132	193	145
13	M	L	S	5	3	126	187	145	73	M	L	S	5	2	129	197	145
14	M	L	S	5	0	136	195	143	74	M	L	S	5	2	126	190	143
15	M	M	S	4	11	129	182	151	**75**	M	L	S	5	5	134	192	155
16	M	L	S	4	10	122	174	141	76	M	M	S	5	1	126	178	144
17	M	D	S	5	1	132	190	149	77	D	M	C	5	1	131	182	146
18	M	L	W	4	11	129	193	152	78	D	D	W	4	10	130	179	146
19	M	L	S	4	9	133	192	149	79	M	M	S	5	2	138	199	153
20	M	M	W	5	2	128	183	140	**80**	D	L	S	4	9	130	182	141
21	M	M	S	4	10	135	187	152	81	M	D	W	4	9	122	172	133
22	F	...	S	5	2	130	172	140	82	M	L	S	5	1	137	188	152
23	M	D	S	5	0	130	193	144	83	M	D	S	4	11	133	182	143
24	D	D	S	5	2	125	183	141	84	M	M	S	5	2	128	180	141
25	M	L	S	5	0	132	178	142	**85**	M	L	S	4	11	126	184	145
26	M	L	S	5	1	132	189	144	86	M	L	S	5	0	126	186	149
27	M	L	S	5	1	129	187	151	87	D	M	S	5	2	126	190	152
28	M	M	S	5	0	124	181	142	88	M	M	S	5	4	133	185	144
29	F	L	S	5	3	134	194	152	89	M	M	S	4	10	125	186	141
30	M	M	S	5	2	129	188	151	**90**	M	L	S	4	11	132	185	147
31	D	L	S	4	8	132	189	148	91	M	M	S	5	3	133	182	149
32	M	L	S	5	0	128	189	142	92	M	D	W	5	1	130	176	142
33	M	M	S	5	1	133	192	151	93	M	M	S	4	9	125	180	139
34	M	L	S	5	5	131	186	146	94	M	M	S	5	0	131	180	149
35	M	L	S	5	2	131	193	144	**95**	M	L	S	5	0	130	179	142
36	D	M	S	5	4	125	186	138	96	M	L	S	5	2	128	189	146
37	M	M	W	5	2	137	188	150	97	M	L	S	4	11	129	175	139
38	M	M	S	4	10	132	186	141	98	M	M	S	4	9	130	181	140
39	M	M	S	5	0	125	187	144	99	D	L	S	5	5	130	195	155
40	D	L	S	5	3	128	193	147	**100**	M	M	S	5	0	126	180	145
41	M	L	S	5	0	131	191	148	101	D	D	S	5	2	131	190	158
43	D	M	S	5	1	130	188	145	102	D	L	S	5	8	139	201	153
42	M	L	S	5	1	131	193	137	103	D	M	S	4	9	127	186	143
44	D	D	S	5	2	128	182	148	104	D	L	C	4	8	125	172	139
45	M	M	S	5	5	133	192	143	**105**	M	M	S	4	9	123	180	142
46	M	L	S	5	3	134	194	148	106	M	L	S	4	8	126	178	138
47	D	L	S	5	2	133	184	145	107	M	L	S	5	2	140	185	145
48	D	M	S	5	1	132	184	145	108	F	L	S	5	2	140	187	144
49	M	M	S	4	11	136	186	145	109	M	L	S	5	0	128	187	144
50	M	M	S	4	11	125	184	145	**110**	M	L	S	5	3	134	190	144
51	D	M	C	5	1	129	186	154	111	M	L	S	5	3	129	188	142
52	M	D	S	4	10	126	185	147	112	M	L	C	4	10	136	185	145
53	M	L	S	5	7	129	184	145	113	D	M	C	5	3	137	189	148
54	M	M	S	4	3	125	179	151	114	M	L	S	4	8	129	186	147
55	M	M	S	4	10	125	179	141	**115**	D	L	S	5	0	130	191	150
56	M	M	S	5	2	138	202	154	116	D	D	S	5	0	132	185	142
57	D	M	S	5	2	132	186	145	117	M	M	C	4	11	135	206	159
58	M	L	S	5	4	130	177	149	118	M	L	S	5	3	130	186	143
59	M	L	S	5	0	134	190	146	119	M	L	S	5	4	137	191	150
60	M	M	S	5	1	132	182	140	**120**	M	L	S	5	6	135	191	148
61	M	M	S	4	11	126	182	143	121	M	L	W	4	7	133	191	148
62	M	M	S	5	2	125	185	147	122	M	M	S	4	11	124	178	140
63	D	M	C	5	0	121	186	144	123	M	L	S	5	3	126	180	146
64	F	L	S	5	2	125	179	147	124	D	D	W	4	11	125	180	142
65	M	M	S	5	4	129	202	151	**125**	D	M	R	5	0	138	185	150
66	M	M	S	5	2	127	188	146	126	M	M	C	5	2	135	179	148
67	M	L	S	5	2	125	171	140	127	M	L	S	5	2	126	181	139
68	D	L	W	5	1	125	180	140	128	F	L	S	5	2	125	187	142
69	M	L	S	5	2	134	189	144	129	M	L	S	5	3	131	191	149
70	M	L	S	5	2	120	178	141	**130**	M	L	S	5	1	127	184	142

III.—Dundee District Asylum.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
131	M	L	S	5	3	127	183	149	166	M	L	W	4	10	125	174	148
132	M	L	S	4	10	130	178	145	167	D	D	S	5	1	137	180	148
133	M	L	S	5	4	132	199	152	168	D	D	S	5	5	135	188	148
134	M	L	S	5	1	137	190	146	169	M	L	S	5	2	133	185	142
135	D	D	S	4	11	130	192	145	**170**	M	M	S	5	0	131	192	146
136	M	L	R	5	3	130	178	142	171	M	L	S	5	1	133	185	148
137	M	D	S	5	2	130	183	144	172	M	L	S	4	8	125	184	138
138	M	L	S	4	11	122	182	137	173	D	D	S	5	5	125	194	145
139	D	D	S	5	7	132	178	146	174	D	L	S	5	3	134	194	153
140	M	D	S	5	1	133	186	149	**175**	D	L	S	5	0	129	182	140
141	M	M	W	5	0	128	186	146	176	D	L	C	5	2	136	185	152
142	M	L	S	5	3	131	182	142	177	M	M	S	5	0	126	181	138
143	M	L	S	4	10	129	181	141	178	M	M	S	4	11	135	182	140
144	M	L	S	5	5	135	187	157	179	M	M	S	4	11	135	195	153
145	M	D	S	5	1	134	183	149	**180**	M	D	S	5	0	136	195	145
146	M	L	S	5	0	125	184	146	181	D	D	S	5	1	134	178	139
147	F	L	S	5	7	132	182	143	182	D	D	S	5	0	122	184	142
148	M	L	S	5	0	137	198	156	183	M	D	C	4	10	121	182	145
149	D	L	S	5	1	134	178	142	184	M	M	S	5	3	122	188	149
150	D	D	S	5	4	134	193	144	**185**	D	L	S	5	1	138	196	150
151	M	M	C	5	2	136	188	155	186	M	M	S	5	4	137	177	145
152	M	L	S	5	0	134	183	137	187	M	D	S	4	11	123	183	150
153	F	M	S	5	2	127	178	137	188	M	L	S	4	11	123	184	142
154	D	D	W	4	11	138	195	150	189	M	M	S	5	3	129	196	144
155	M	L	S	4	11	126	173	133	**190**	M	L	S	4	10	131	184	139
156	M	L	S	4	11	124	177	137	191	M	M	S	5	0	126	190	145
157	D	M	S	5	3	136	190	142	192	D	D	C	4	11	125	185	142
158	D	L	S	5	2	135	190	149	193	D	D	S	4	10	132	189	146
159	M	M	S	4	10	125	180	146	194	F	M	S	4	11	127	187	148
160	M	D	S	5	0	124	184	144	**195**	M	M	S	5	2	125	191	139
161	D	D	C	5	2	131	195	147	196	D	D	S	4	11	130	198	157
162	D	M	S	5	3	128	182	142	197	M	L	S	5	0	130	192	146
163	D	M	S	4	11	124	189	147	198	D	D	S	5	4	127	183	145
164	D	L	S	5	1	124	175	138	199	D	D	S	5	4	128	187	141
165	D	L	S	5	1	124	191	138	**200**	D	D	S	5	2	131	190	144

IV.—Edinburgh Royal Asylum.

FEMALES.									FEMALES.								
1	D	D	W	5	3	133	187	145	16	M	M	S	5	3	140	191	151
2	D	D	S	5	6	135	182	150	17	F	M	S	5	0	131	179	136
3	M	M	S	5	3	140	182	142	18	D	D	S	4	11	137	176	149
4	D	D	S	5	0	124	178	139	19	D	L	S	5	1	134	186	141
5	M	L	S	5	1	126	177	138	**20**	D	M	S	5	0	141	190	145
6	D	M	S	4	8	129	177	139	21	D	L	S	5	2	135	183	147
7	D	L	S	4	8	133	189	146	22	D	D	C	5	4	132	192	146
8	D	L	S	5	2	128	179	139	23	M	L	S	5	2	139	189	142
9	M	L	S	4	11	139	184	138	24	M	D	S	5	1	135	185	142
10	M	L	S	5	0	129	187	139	**25**	M	D	S	4	9	131	186	147
11	D	M	S	5	7	139	198	160	26	M	L	C	5	1	132	185	141
12	D	D	S	5	3	134	188	147	27	M	D	S	5	1	136	191	151
13	M	M	S	5	2	127	179	132	28	D	M	S	4	5	132	186	145
14	M	D	S	5	1	140	186	149	29	M	L	C	4	10	126	173	129
15	M	L	S	5	0	133	179	139	**30**	D	L	W	4	10	128	184	146

IV.—Edinburgh Royal Asylum.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
31	D	M	S	5	3	137	187	147	91	M	L	S	4	11	136	184	136
32	D	M	S	5	6	138	193	151	92	D	D	S	5	4	132	182	141
33	M	M	W	5	4	144	188	148	93	D	L	S	5	0	133	191	148
34	M	M	S	5	0	136	193	145	94	M	L	S	5	4	138	194	150
35	D	M	S	5	1	132	193	144	**95**	M	L	W	5	5	136	193	143
36	D	D	S	5	0	127	181	138	96	M	L	S	5	0	126	182	140
37	M	L	W	5	7	142	192	153	97	D	M	S	4	11	137	189	154
38	M	L	S	5	2	124	181	139	98	D	M	S	5	1	130	175	146
39	M	M	S	5	0	133	184	144	99	R	L	S	4	11	138	185	145
40	D	L	W	4	8	127	188	141	**100**	M	L	S	5	0	130	181	148
41	F	L	S	4	3	133	182	142	101	D	D	S	4	10	133	183	136
42	M	L	W	5	1	134	185	142	102	D	D	S	5	2	136	194	145
43	M	L	S	5	2	136	182	145	103	D	L	S	5	1	138	183	131
44	M	L	W	5	0	136	183	150	104	D	L	S	5	1	135	190	148
45	M	M	S	5	2	137	192	141	**105**	D	L	W	4	8	122	187	142
46	M	L	W	5	4	139	188	156	106	M	M	W	5	0	127	192	146
47	D	D	S	4	11	135	191	148	107	M	L	C	5	4	124	182	142
48	D	L	C	5	3	142	193	146	108	D	L	S	5	2	127	181	138
49	M	L	C	4	11	128	177	138	109	D	L	S	5	1	124	190	142
50	D	L	W	4	11	127	191	142	**110**	M	L	S	5	2	131	187	142
51	D	M	S	5	0	136	181	143	111	D	D	C	5	2	135	185	148
52	D	L	S	5	2	137	188	142	112	D	L	S	5	5	134	183	148
53	D	L	S	5	2	131	181	148	113	M	L	C	5	1	134	185	145
54	D	D	S	5	2	126	177	143	114	D	D	S	5	2	131	185	148
55	M	L	S	5	2	126	184	146	**115**	D	L	S	5	0	144	184	148
56	M	M	S	5	2	138	185	158	116	D	D	S	5	4	139	188	145
57	D	D	S	4	11	120	177	140	117	D	M	S	4	10	131	182	140
58	M	L	S	4	11	131	181	137	118	D	L	S	4	10	142	196	150
59	M	L	S	5	0	135	185	146	119	D	L	S	5	2	141	181	147
60	D	L	C	5	0	131	183	146	**120**	R	M	S	5	1	137	184	146
61	D	D	S	5	3	138	184	146	121	M	M	S	5	1	135	190	140
62	L	L	C	5	1	132	183	143	122	M	M	S	5	2	139	189	148
63	D	D	S	5	4	129	182	139	123	D	D	S	5	0	131	179	140
64	D	L	S	4	10	128	184	142	124	D	D	S	4	11	128	184	144
65	M	D	W	5	0	136	200	150	**125**	D	D	S	5	1	141	187	154
66	M	L	W	4	7	130	168	128	126	M	M	C	4	11	135	185	138
67	D	D	S	5	5	130	182	146	127	D	D	S	4	11	131	177	144
68	M	M	S	5	1	133	186	143	128	D	D	S	5	4	137	179	143
69	D	M	C	4	10	133	187	133	129	M	L	S	5	0	128	188	148
70	D	M	W	4	11	135	181	138	**130**	D	D	S	5	4	138	194	143
71	D	M	C	4	10	130	184	139	131	D	D	S	4	10	127	185	145
72	D	D	S	5	3	140	183	141	132	M	D	S	5	3	127	178	138
73	M	D	W	4	10	124	179	139	133	D	M	S	5	0	129	184	147
74	D	L	W	4	9	131	181	144	134	M	D	S	5	1	132	186	142
75	D	D	S	5	1	127	182	147	**135**	D	D	S	5	3	137	193	143
76	D	L	S	5	0	133	181	141	136	M	L	W	5	0	138	193	152
77	M	L	C	4	11	140	183	144	137	M	M	W	5	2	137	187	151
78	M	M	S	5	0	126	181	150	138	M	M	S	5	4	130	191	142
79	M	L	S	5	1	122	180	137	139	D	L	C	4	11	146	197	154
80	D	L	W	5	3	142	190	141	**140**	D	L	S	5	4	142	197	145
81	D	D	S	5	1	132	185	142	141	D	D	S	5	1	135	182	145
82	D	L	S	5	1	133	185	143	142	F	L	S	5	3	141	186	146
83	M	D	S	5	2	126	177	136	143	D	M	S	5	3	138	189	149
84	M	L	S	5	1	138	177	142	144	M	D	S	4	9	134	185	143
85	D	L	S	5	3	132	190	146	**145**	D	M	W	5	0	130	196	151
86	M	L	S	5	2	131	176	141	146	M	L	S	4	8	127	182	145
87	M	M	S	5	2	131	182	138	147	M	L	S	4	11	130	193	145
88	D	D	S	5	1	129	186	145	148	M	D	S	5	3	128	185	150
89	F	L	S	4	10	140	189	144	149	M	L	S	5	0	133	188	149
90	M	L	S	5	3	133	191	152	**150**	D	D	C	5	0	131	176	138

IV.—Edinburgh Royal Asylum.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
151	D	M	W	5	0	141	187	143	**180**	M	M	S	5	1	134	182	140
152	D	D	S	5	0	137	180	138	181	D	L	S	4	11	131	187	139
153	M	L	C	5	1	136	180	138	182	D	L	S	5	0	126	184	150
154	D	D	C	5	2	135	192	156	183	D	D	W	4	11	132	191	149
155	D	L	S	5	4	141	186	146	184	D	M	S	5	9	151	198	159
156	R	L	S	5	3	141	188	152	**185**	M	D	S	5	1	128	180	140
157	D	L	W	5	3	133	180	145	186	M	L	C	4	11	132	193	149
158	D	D	S	4	10	134	190	145	187	D	L	S	5	2	133	185	144
159	D	L	S	4	11	129	176	133	188	M	L	S	5	1	135	169	139
160	D	D	S	5	4	135	180	140	189	D	M	S	5	3	131	183	145
161	F	L	W	4	11	133	183	142	**190**	M	L	S	5	2	135	183	146
162	M	L	S	5	2	139	176	124	191	D	D	S	5	2	144	194	154
163	M	L	S	4	9	135	187	141	192	D	L	S	5	3	128	188	142
164	D	M	S	5	2	135	192	152	193	D	M	S	4	9	133	181	144
165	M	L	S	4	11	135	188	144	194	M	L	S	4	10	129	172	133
166	D	L	C	4	11	134	195	149	**195**	M	M	C	5	3	133	195	153
167	D	L	W	5	3	129	182	141	196	D	L	C	5	5	142	187	145
168	D	L	S	5	1	129	185	144	197	M	L	W	4	7	133	188	149
169	...	L	S	4	9	124	189	140	198	D	L	S	4	0	137	183	148
170	D	D	S	5	6	137	188	152	199	D	D	C	5	0	130	177	142
171	D	D	S	4	10	139	187	144	**200**	M	D	S	4	10	132	185	146
172	...	L	C	5	4	138	196	148	201	D	M	S	5	6	143	192	146
173	D	D	W	5	1	126	186	143	202	D	L	S	5	3	130	184	146
174	M	L	W	4	10	120	189	138	203	M	L	C	5	2	141	187	153
175	M	L	S	4	10	129	183	143	204	M	L	S	5	3	129	183	139
176	D	L	S	4	10	129	186	143	**205**	D	M	S	5	5	139	194	142
177	M	L	S	5	3	138	191	149	206	D	M	S	5	3	146	193	146
178	M	M	S	5	3	145	187	145	207	M	L	C	5	3	145	192	149
179	R	L	S	5	0	139	185	152									

V.—Montrose Royal Asylum.

FEMALES.									FEMALES.								
1	D	M	S	4	11	131	186	145	21	...	M	S	5	0	125	182	144
2	D	D	S	4	11	129	177	138	22	D	M	S	4	9	144	198	155
3	D	M	S	4	10	133	181	141	23	M	M	S	4	10	119	172	138
4	...	M	S	4	5	123	180	140	24	...	L	S	5	0	132	185	153
5	...	M	S	4	10	148	191	154	**25**	D	M	S	5	1	122	178	143
6	D	D	C	4	9	129	182	147	26	R	M	S	5	2	131	186	148
7	D	M	S	5	0	126	174	145	27	D	D	S	5	4	132	185	148
8	R	D	S	4	10	120	181	142	28	D	M	S	5	0	132	178	137
9	D	M	S	5	2	138	183	146	29	..	M	S	5	3	122	192	148
10	...	M	S	5	2	139	188	149	**30**	D	M	S	4	10	132	185	147
11	D	M	S	5	1	128	183	149	31	D	D	S	5	4	135	191	142
12	D	M	S	5	0	129	184	140	32	D	D	S	5	0	129	184	142
13	D	M	S	4	10	130	173	139	33	D	M	S	4	11	131	195	152
14	D	M	S	4	5	128	181	149	34	R	M	S	5	0	130	180	143
15	D	M	S	5	4	125	182	145	**35**	...	M	S	4	11	127	183	149
16	...	M	S	5	0	127	185	146	36	D	M	S	5	1	128	187	150
17	...	M	S	5	3	131	195	151	37	..	M	S	4	11	128	189	158
18	...	M	C	5	2	134	197	150	38	D	M	S	5	4	129	176	143
19	D	M	S	5	5	127	186	154	39	D	M	S	5	1	135	176	139
20	...	M	S	5	1	126	184	150	**40**	M	M	S	4	9	127	175	142

V.—Montrose Royal Asylum.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
41	...	M	S	5	1	124	189	151	97	M	L	S	5	3	126	184	136
42	M	D	S	5	7	143	188	147	98	...	M	S	4	11	125	184	144
43	..	D	S	5	2	122	196	144	99	D	D	S	5	1	132	201	145
44	M	L	S	5	0	131	182	136	**100**	...	L	S	4	11	135	192	141
45	M	M	S	5	1	130	185	148	101	D	L	S	4	10	135	185	148
46	M	M	C	5	6	136	186	151	102	M	M	S	5	1	140	179	143
47	D	M	S	5	2	132	182	138	103	D	M	S	5	0	133	175	143
48	D	D	S	4	11	123	180	142	104	D	M	S	5	4	140	191	151
49	...	M	S	4	10	128	181	148	**105**	M	M	S	4	11	139	189	148
50	...	M	S	5	0	127	184	147	106	R	D	C	5	0	134	175	153
51	M	M	S	5	6	131	193	151	107	D	M	S	5	2	150	186	148
52	D	M	S	5	0	130	185	149	108	M	D	S	5	2	137	186	144
53	M	M	S	5	5	123	189	157	109	L	M	S	5	0	133	184	151
54	D	M	S	5	0	126	180	146	**110**	M	M	S	5	2	135	184	146
55	D	D	S	5	1	127	182	149	111	M	M	S	5	2	128	185	152
56	...	M	S	5	1	129	191	148	112	L	M	S	5	6	131	191	141
57	D	M	S	5	5	124	181	141	113	D	M	C	5	5	139	184	143
58	...	M	S	5	3	121	192	142	114	D	M	S	5	2	141	185	149
59	D	M	S	5	1	131	186	152	**115**	...	M	S	5	1	140	190	143
60	...	M	S	5	3	128	182	145	116	M	L	S	5	0	126	179	147
61	D	D	S	4	10	124	178	150	117	...	D	S	5	4	128	182	156
62	R	M	S	5	6	127	181	142	118	...	L	S	5	3	139	196	161
63	M	L	S	5	3	131	191	149	119	D	M	...	5	3	134	180	149
64	M	M	S	5	1	135	188	149	**120**	...	D	S	5	2	134	191	141
65	M	L	S	5	5	143	189	149	121	M	M	C	5	3	136	195	146
66	...	M	S	5	2	135	188	149	122	...	D	S	4	10	134	191	144
67	D	D	S	4	8	127	183	144	123	D	M	S	5	3	124	183	145
68	M	L	S	5	2	139	181	144	124	D	L	S	4	11	127	185	138
69	M	L	S	5	2	125	175	145	**125**	...	D	S	5	0	134	183	148
70	...	D	S	5	2	136	183	149	126	...	D	S	5	5	138	180	144
71	D	L	S	5	1	143	191	147	127	R	D	S	5	2	140	193	135
72	D	M	S	5	1	128	182	152	128	..	D	S	5	0	136	190	147
73	D	D	S	4	10	122	186	150	129	D	M	S	4	10	138	189	154
74	D	D	S	5	1	121	179	149	**130**	...	M	S	4	10	132	188	139
75	M	M	S	5	4	130	187	146	131	D	M	S	5	1	138	186	141
76	D	D	S	5	6	139	184	149	132	D	M	S	5	1	135	188	145
77	M	L	S	5	0	127	195	145	133	...	D	S	5	3	138	196	147
78	M	M	S	5	4	145	192	155	134	F	L	C	4	10	133	188	144
79	...	D	C	5	1	136	180	153	**135**	...	M	S	4	11	133	190	149
80	M	M	...	5	0	132	188	141	136	D	D	S	4	10	128	180	143
81	D	M	S	4	7	140	184	144	137	...	D	S	5	4	148	202	154
82	D	M	S	5	3	135	195	156	138	D	M	S	5	2	131	188	158
83	M	M	S	5	3	133	181	139	139	M	M	S	5	0	135	186	144
84	...	M	S	5	1	133	191	147	**140**	...	M	S	5	2	131	183	140
85	D	D	S	5	1	142	186	158	141	...	D	S	5	1	132	185	150
86	M	M	S	5	2	132	188	158	142	D	D	S	5	2	137	189	141
87	D	D	C	5	0	123	179	137	143	...	M	S	5	2	125	177	145
88	...	M	...	5	1	126	185	149	144	D	D	S	5	2	145	188	148
89	M	M	S	5	1	130	177	151	**145**	...	D	C	5	3	139	188	144
90	D	M	S	4	11	125	180	159	146	D	M	S	4	7	128	173	134
91	D	M	S	4	10	133	180	141	147	D	M	S	4	11	138	190	151
92	M	L	S	5	5	140	197	151	148	...	D	C	4	11	137	193	146
93	D	L	S	5	0	145	198	156	149	M	M	S	5	0	132	174	146
94	...	D	S	5	4	136	197	155	**150**	D	D	S	4	11	122	178	141
95	...	D	S	5	5	132	192	159	151	...	L	S	5	2	134	192	156
96	D	D	S	5	1	136	186	145									

VI.—Argyll District Asylum.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
1	M	M	S	5	3	138	201	141	61	M	L	S	4	11	128	185	141
2	M	D	S	4	5	133	188	148	62	M	L	S	5	2	127	186	142
3	M	L	S	4	9	133	181	144	63	M	M	S	5	3	137	190	148
4	M	L	S	5	0	135	191	144	64	M	M	S	5	2	119	181	148
5	M	L	S	5	1	137	181	143	**65**	M	M	W	5	5	125	189	141
6	M	L	S	5	1	123	184	137	66	M	L	S	5	1	132	190	156
7	M	L	S	5	3	129	187	148	67	D	D	S	5	3	137	193	153
8	D	M	S	5	5	124	188	144	68	M	L	S	4	5	126	186	143
9	M	M	S	5	0	129	181	147	69	D	L	S	5	3	129	182	144
10	M	D	S	5	2	133	192	148	**70**	M	D	S	5	1	139	201	152
11	M	M	S	5	0	130	193	144	71	M	M	S	5	2	133	193	144
12	M	M	S	4	9	122	182	137	72	M	M	W	4	11	131	190	150
13	D	M	S	5	4	133	198	149	73	M	M	S	5	9	127	188	144
14	M	L	S	5	3	124	182	146	74	M	M	S	5	1	121	178	142
15	M	L	C	5	2	124	196	147	**75**	M	L	S	4	10	125	188	146
16	M	M	S	5	5	124	182	134	76	M	L	S	4	11	127	185	143
17	M	D	S	5	2	133	181	149	77	M	M	S	4	9	123	184	137
18	M	D	S	5	0	132	191	144	78	M	M	S	5	1	123	185	144
19	M	M	S	4	10	124	181	147	79	M	L	S	4	8	124	180	142
20	M	M	S	5	2	127	184	151	**80**	M	D	S	5	5	129	193	150
21	M	L	S	5	2	129	203	153	81	M	L	S	5	0	132	194	146
22	M	D	S	5	0	136	205	149	82	M	D	S	5	0	130	194	148
23	M	M	C	5	2	135	196	148	83	M	M	S	5	2	123	172	135
24	M	D	S	5	2	134	187	146	84	M	L	S	5	7	134	179	144
25	M	L	S	5	2	132	185	151	**85**	D	L	C	5	1	130	194	149
26	D	M	S	5	5	136	194	146	86	M	M	S	5	0	121	189	146
27	M	D	S	5	2	129	193	143	87	D	D	S	5	1	130	185	146
28	M	L	S	5	6	133	179	144	88	M	D	S	5	2	132	182	144
29	M	L	S	5	0	129	181	142	89	M	L	S	5	1	135	189	148
30	M	D	S	5	3	129	183	151	**90**	M	M	S	5	1	131	192	141
31	M	M	S	5	1	134	195	150	91	M	M	S	4	10	131	195	141
32	D	D	S	5	1	131	191	150	92	F	L	S	4	10	130	184	149
33	M	M	S	5	4	129	179	144	93	M	L	S	4	11	129	186	151
34	D	D	S	5	7	132	201	150	94	M	M	S	5	0	130	190	151
35	M	M	S	5	4	123	190	146	**95**	M	M	S	4	11	139	189	151
36	M	M	S	5	2	130	184	143	96	M	M	S	4	9	126	184	140
37	M	D	S	5	6	129	193	147	97	M	D	W	5	3	132	190	146
38	F	L	S	5	5	135	194	150	98	M	D	S	5	4	130	185	140
39	M	D	S	5	6	132	188	147	99	M	M	S	4	11	125	186	140
40	M	M	S	5	1	128	192	146	**100**	D	M	S	5	3	133	192	144
41	M	L	S	5	3	132	193	141	101	D	M	S	5	0	127	182	138
42	M	D	S	5	1	130	181	146	102	M	L	S	5	2	128	194	150
43	M	D	S	5	2	128	190	142	103	D	L	S	5	4	140	191	146
44	M	L	S	5	1	124	192	143	104	D	L	S	5	2	137	196	144
45	M	M	W	5	5	140	204	150	**105**	D	M	S	5	2	135	188	144
46	D	M	S	5	3	133	193	149	106	M	M	S	4	9	127	192	146
47	M	L	S	5	1	126	187	153	107	M	L	S	4	11	121	196	145
48	M	D	S	4	11	126	186	146	108	D	D	S	4	11	127	191	141
49	M	L	S	5	2	132	184	144	109	M	L	S	4	9	130	174	145
50	M	L	S	5	5	127	189	137	**110**	D	L	S	5	0	130	183	143
51	M	M	W	5	6	134	187	148	111	M	L	S	5	2	140	200	144
52	M	M	W	5	4	134	196	154	112	M	L	S	5	2	131	188	155
53	M	L	S	5	1	128	185	148	113	D	D	S	5	4	133	189	143
54	M	M	S	5	2	130	186	142	114	M	L	S	5	2	129	181	138
55	M	L	S	4	10	130	194	153	**115**	D	M	S	5	4	133	195	151
56	M	L	S	5	5	132	186	144	116	M	M	S	5	5	124	182	144
57	M	M	S	5	2	132	184	148	117	M	M	S	5	7	133	202	158
58	D	M	S	5	4	129	193	135	118	M	L	S	5	4	130	194	149
59	M	L	S	5	1	130	182	141	119	M	D	S	5	2	131	195	150
60	M	M	S	5	2	129	190	143	**120**	D	D	S	4	11	127	190	138

VI.—Argyll District Asylum.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
121	M	L	S	4	11	125	179	141	**160**	D	M	S	5	2	130	186	148
122	M	L	S	5	2	125	188	149	161	M	L	S	5	3	128	183	149
123	M	M	W	5	0	132	185	146	162	M	D	S	5	1	132	185	145
124	F	L	W	5	5	135	197	155	163	M	M	S	5	2	126	179	144
125	F	L	S	5	2	130	185	141	164	M	L	S	5	2	129	187	142
126	M	D	S	5	3	127	188	148	**165**	M	M	S	5	0	129	197	145
127	M	M	W	5	7	131	201	148	166	M	M	W	5	0	131	199	143
128	L	M	S	4	11	132	197	141	167	M	D	S	5	1	128	196	150
129	M	D	S	5	1	135	183	149	168	M	L	S	5	4	126	192	145
130	M	D	S	5	5	133	185	148	169	M	D	S	5	1	133	196	151
131	M	M	S	4	11	128	187	147	**170**	D	M	S	5	3	135	195	146
132	M	L	S	5	2	128	179	146	171	M	L	S	5	6	137	194	150
133	M	L	S	5	0	124	179	139	172	M	M	W	4	11	132	193	148
134	M	L	S	5	1	120	191	151	173	D	L	S	5	3	141	196	148
135	M	D	S	5	4	130	186	153	174	M	D	S	5	0	135	184	144
136	D	L	S	4	11	137	198	138	**175**	M	L	W	5	7	132	190	150
137	M	L	S	4	11	131	185	140	176	M	L	W	5	0	134	188	143
138	M	L	S	5	1	134	197	149	177	D	D	S	5	2	127	184	143
139	M	M	S	5	4	132	200	143	178	M	D	S	5	3	127	189	148
140	M	D	S	5	6	133	188	143	179	M	D	S	5	2	126	192	138
141	M	M	S	5	4	132	201	151	**180**	D	L	S	5	4	130	191	147
142	D	M	S	5	3	127	190	140	181	D	M	S	5	5	134	190	142
143	D	L	S	4	11	130	194	141	182	D	D	S	5	4	134	188	148
144	M	L	S	4	11	127	191	151	183	M	D	S	5	2	131	194	150
145	M	L	S	5	2	127	188	140	184	M	L	W	4	10	130	190	142
146	M	D	S	5	2	121	185	144	**185**	D	D	S	5	4	138	192	145
147	M	M	S	5	0	132	192	154	186	M	L	S	5	1	129	194	148
148	M	M	S	4	7	131	189	133	187	M	L	S	4	10	123	187	143
149	M	D	S	5	4	128	191	148	188	M	L	S	5	4	130	195	146
150	M	L	S	4	10	118	179	138	189	M	...	C	5	4	125	185	149
151	M	D	S	5	0	126	195	148	**190**	D	D	S	5	0	128	188	146
152	D	D	S	5	2	127	189	141	191	M	D	S	5	0	130	190	145
153	M	D	S	5	2	126	187	141	192	M	L	S	5	4	136	189	150
154	D	M	S	5	0	125	189	145	193	D	D	S	5	5	130	194	151
155	D	M	S	5	0	129	186	145	194	M	L	S	5	4	137	188	150
156	M	L	S	5	3	130	189	149	**195**	M	M	S	5	1	135	182	139
157	M	L	S	5	1	133	182	146	196	M	M	S	5	3	133	189	147
158	M	M	S	5	0	129	181	143	197	D	L	S	5	0	127	196	147
159	M	D	S	5	3	131	190	147									

VII.—Ayr District Asylum.

FEMALES.									FEMALES.								
1	M	M	S	4	10	129	191	138	11	D	M	S	5	5	132	185	143
2	M	L	S	5	0	129	179	149	12	M	L	S	5	2	129	185	146
3	M	L	S	4	11	134	189	145	13	D	L	S	5	0	134	184	156
4	M	M	S	5	0	131	192	153	14	M	M	S	5	0	132	185	147
5	M	D	S	4	11	129	184	141	**15**	M	L	S	5	2	120	192	142
6	M	M	W	5	1	130	182	147	16	M	D	S	5	1	131	185	147
7	M	L	S	4	10	134	193	146	17	M	D	S	5	1	130	194	142
8	M	D	W	5	1	127	181	143	18	D	L	S	5	5	138	207	157
9	D	L	S	5	5	138	189	139	19	M	M	S	5	0	129	187	143
10	M	L	S	5	5	132	188	147	**20**	M	M	S	5	4	134	190	143

VII.—Ayr District Asylum.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
21	M	M	S	5	1	135	193	150	81	D	L	S	4	11	124	180	146
22	M	L	C	5	2	131	188	142	82	M	L	S	4	11	125	184	135
23	M	L	C	5	3	133	186	147	83	M	M	S	5	5	133	194	145
24	M	L	S	5	2	131	183	139	84	M	L	S	4	11	124	184	139
25	M	D	C	5	0	129	185	153	**85**	D	D	S	5	2	132	191	144
26	M	L	S	5	3	130	188	149	86	M	L	S	5	2	123	194	146
27	M	L	S	5	1	130	190	151	87	M	L	C	5	1	121	178	142
28	D	D	S	5	5	130	192	146	88	M	M	S	4	10	123	171	142
29	M	L	S	5	0	132	194	150	89	M	D	S	5	1	121	175	137
30	M	L	S	5	2	124	185	138	**90**	M	L	S	5	2	125	190	147
31	M	L	S	5	0	120	184	141	91	M	L	S	5	1	130	195	152
32	M	D	S	5	2	129	185	144	92	D	L	S	5	0	129	198	147
33	D	L	S	5	0	132	178	145	93	M	L	S	5	4	136	193	149
34	D	M	S	5	2	131	190	144	94	M	L	S	5	6	133	196	151
35	M	L	S	5	1	125	185	141	**95**	M	M	S	5	4	133	198	158
36	M	L	S	4	11	129	183	159	96	M	M	S	5	0	124	177	140
37	M	L	S	5	1	135	200	154	97	D	D	S	5	5	130	199	145
38	M	L	S	5	7	132	186	140	98	M	M	W	5	3	131	197	146
39	M	M	S	5	1	129	185	142	99	M	L	S	5	5	135	183	145
40	M	M	S	5	4	129	185	139	**100**	M	L	S	5	4	137	188	150
41	D	L	S	5	2	129	189	145	101	M	L	S	5	1	135	197	154
42	M	D	S	5	2	129	184	147	102	D	D	W	4	10	115	172	122
43	M	M	S	5	1	132	189	141	103	M	L	S	4	10	130	191	144
44	M	L	S	5	4	121	183	142	104	M	L	S	5	1	131	187	144
45	M	L	S	5	0	133	193	155	**105**	M	L	S	5	2	129	188	145
46	M	D	S	5	0	131	180	146	106	M	M	S	4	10	120	183	142
47	M	...	S	5	0	134	192	142	107	M	M	S	5	3	134	193	144
48	M	M	S	5	4	132	188	148	108	M	M	C	4	7	124	180	138
49	M	L	S	5	1	133	196	145	109	M	L	R	5	1	132	191	146
50	M	L	S	5	1	121	180	137	**110**	M	L	C	4	6	130	197	149
51	M	M	C	4	7	123	186	146	111	M	L	S	4	8	128	185	146
52	M	L	W	5	2	132	186	149	112	M	L	S	4	11	129	180	145
53	M	L	S	5	2	129	199	151	113	M	L	S	5	2	130	184	150
54	M	L	S	4	9	129	180	137	114	M	D	S	5	0	126	187	145
55	M	D	S	5	1	127	183	142	**115**	D	M	S	4	10	130	191	150
56	D	M	S	4	8	121	179	143	116	D	M	S	5	2	130	177	144
57	M	L	S	5	4	124	193	145	117	M	M	S	4	11	128	187	147
58	M	D	S	5	2	130	191	146	118	M	D	S	5	2	127	189	145
59	M	M	S	5	1	122	190	151	119	M	L	S	5	3	130	191	146
60	D	D	S	5	3	121	186	148	**120**	M	L	S	4	11	132	191	148
61	M	L	W	5	0	129	186	142	121	M	M	S	4	1	127	187	147
62	M	M	S	5	3	124	190	137	122	F	L	S	5	2	128	196	151
63	M	L	S	5	3	133	184	149	123	D	D	S	5	1	130	179	149
64	M	D	S	5	3	129	185	141	124	M	D	S	4	10	130	181	135
65	D	L	S	5	1	125	190	149	**125**	M	L	S	4	9	123	184	149
66	M	D	S	5	8	136	201	153	126	M	M	S	5	0	127	171	144
67	M	L	S	5	1	131	181	147	127	M	L	S	5	2	129	191	158
68	M	L	S	5	1	132	186	151	128	M	M	S	5	6	132	185	139
69	M	L	S	5	2	132	194	137	129	M	M	S	5	2	129	190	149
70	M	D	S	5	3	128	200	152	**130**	M	D	C	4	7	132	185	148
71	M	L	S	4	11	130	189	151	131	R	L	S	4	10	124	182	147
72	D	D	S	5	2	128	190	149	132	M	M	S	5	2	127	190	143
73	M	L	S	5	6	134	191	149	133	M	L	S	5	6	126	180	144
74	D	D	S	5	2	131	196	148	134	M	L	C	4	11	129	186	145
75	M	D	S	5	2	129	190	145	**135**	D	M	S	5	3	139	199	151
76	M	D	S	5	5	141	201	156	136	D	M	S	5	6	137	181	152
77	M	L	S	5	1	133	189	153	137	M	M	S	5	3	129	189	144
78	M	L	S	5	5	131	187	150	138	M	L	S	5	2	130	193	143
79	D	...	S	4	11	130	187	148	139	M	L	W	5	0	131	173	140
80	M	L	S	4	10	122	178	137	**140**	M	L	S	5	1	136	192	145

VII.—Ayr District Asylum.

FEMALES.

No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
141	D	D	S	4	8	127	187	143
142	D	M	S	5	2	136	196	149
143	D	L	S	5	1	127	182	148
144	D	D	S	5	4	131	190	145
145	M	M	S	4	9	125	189	146
146	M	L	S	4	8	125	175	142
147	D	D	S	4	9	130	188	137
148	M	L	S	5	1	126	181	138
149	D	D	S	5	1	126	183	146
150	M	L	S	5	1	133	184	142
151	D	M	S	4	10	125	185	139
152	M	L	S	5	0	125	183	145
153	M	L	S	4	10	125	173	146
154	M	M	S	4	11	127	191	148
155	F	L	S	5	0	127	185	133
156	M	D	S	5	2	130	195	154
157	M	L	S	4	11	131	192	144
158	M	L	S	5	4	133	192	137
159	D	L	S	4	9	128	190	145
160	M	L	S	5	0	131	192	148
161	D	L	S	5	7	129	190	142
162	M	L	W	5	0	132	183	153
163	M	M	C	4	11	131	185	150
164	M	L	S	5	0	131	183	145
165	M	L	S	5	2	126	187	137
166	M	D	S	5	0	122	181	130
167	M	L	S	6	0	127	188	142
168	D	D	S	5	3	131	195	142
169	M	M	S	5	3	128	183	146
170	M	L	W	5	0	119	179	130
171	D	L	S	5	1	128	192	146
172	D	D	S	5	3	128	182	140
173	M	M	S	5	0	132	187	149
174	D	M	S	4	11	122	187	143
175	M	D	R	5	6	130	192	146
176	M	L	S	5	2	136	195	155
177	D	L	S	5	2	131	182	146
178	M	D	C	4	11	133	190	150
179	F	L	S	4	10	128	186	144
180	M	L	C	5	1	134	190	141
181	M	M	S	5	1	131	188	145
182	M	L	S	5	3	131	185	150
183	M	M	S	5	1	131	191	146
184	D	D	S	4	2	139	195	143
185	M	L	S	5	3	131	190	141
186	M	M	S	5	2	125	180	145
187	M	L	S	5	4	131	189	142
188	M	M	W	4	10	126	189	145
189	D	M	S	5	3	138	196	147
190	M	L	S	4	8	114	174	140
191	M	M	W	5	5	131	199	142
192	M	D	S	4	10	126	173	135
193	M	L	S	5	3	132	187	147
194	M	L	S	5	0	127	187	146
195	D	L	S	4	8	125	174	124
196	M	M	S	4	10	134	191	152
197	M	L	...	5	3	125	178	140
198	M	M	S	5	3	135	207	157
199	D	L	S	4	11	135	188	149
200	M	M	S	5	4	125	194	145
201	M	M	S	4	10	134	195	153
202	M	L	W	5	3	135	183	145
203	M	M	S	4	11	129	188	146
204	M	M	S	5	1	126	192	151
205	M	L	S	4	10	123	192	150
206	M	L	S	5	3	133	193	153
207	M	L	S	4	11	128	189	149
208	M	L	S	4	11	124	181	142
209	M	L	S	4	10	128	186	149
210	M	L	C	5	1	130	190	143
211	M	M	W	5	2	126	183	137
212	M	L	W	5	2	125	190	147
213	M	L	W	5	6	124	189	145
214	M	L	S	5	5	132	186	147
215	M	L	S	5	1	129	177	143
216	M	L	S	5	1	132	186	144
217	D	L	S	4	11	129	191	153
218	M	D	C	5	5	127	200	143
219	D	M	S	5	3	130	189	143
220	D	D	S	4	10	120	183	144
221	F	M	S	5	3	125	180	140
222	M	L	S	5	5	125	194	146
223	D	M	S	5	2	133	196	145
224	M	M	W	4	10	131	183	144
225	D	M	S	5	6	137	181	149
226	M	D	S	4	8	132	198	151
227	M	L	S	4	9	128	182	141
228	M	M	S	4	11	130	193	145
229	M	L	S	5	2	127	185	141
230	M	D	S	5	2	130	184	141
231	M	L	S	4	9	133	195	149
232	M	L	S	5	2	137	192	159
233	M	D	S	4	11	126	184	141
234	M	L	S	4	11	131	185	141
235	M	M	S	5	1	130	186	147
236	M	L	S	5	2	132	185	144
237	M	L	S	4	9	131	189	151
238	M	M	S	4	9	128	199	154
239	D	L	S	4	11	132	198	159
240	M	L	C	4	5	124	183	135
241	M	D	S	5	4	127	189	150
242	M	D	S	5	4	136	202	145
243	M	L	S	4	10	134	192	146
244	M	L	S	5	0	133	183	140
245	M	L	S	4	10	139	200	153
246	M	D	S	4	7	126	195	144
247	D	D	W	4	9	132	194	148
248	M	L	S	5	3	129	193	147

VIII.—Banff District Asylum.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.				H.	L.	B.		Hair.	Eyes.				H.	L.	B.
				ft.	in.	mm.	mm.	mm.					ft.	in.	mm.	mm.	mm.
1	M	M	C	5	5	136	183	152	32	D	M	S	5	3	132	184	149
2	D	M	C	5	1	126	187	146	33	...	D	S	5	3	139	189	154
3	M	M	S	4	11	129	178	147	34	D	D	S	5	2	130	192	156
4	D	D	S	5	0	120	182	142	**35**	M	M	S	4	10	134	184	146
5	M	M	S	5	0	128	182	148	36	...	M	S	5	8	131	184	145
6	M	M	S	5	0	123	178	150	37	...	D	C	5	8	134	188	143
7	M	M	C	5	2	137	183	143	38	D	D	S	5	5	125	188	147
8	D	M	S	5	2	130	188	141	39	D	M	S	5	2	130	185	151
9	D	L	S	5	2	123	181	148	**40**	D	M	S	5	2	131	197	150
10	D	M	S	5	6	138	198	152	41	D	M	S	5	1	133	180	152
11	D	M	S	5	3	135	187	151	42	D	M	S	5	9	132	182	147
12	D	M	S	5	3	136	189	146	43	D	M	S	5	1	135	187	146
13	R	M	S	5	2	125	175	149	44	...	M	S	5	1	132	192	147
14	...	D	S	5	5	131	190	157	**45**	D	M	S	5	2	123	176	139
15	...	M	S	5	8	133	181	149	46	...	M	C	5	1	133	188	139
16	...	M	S	5	1	125	182	146	47	M	M	S	5	1	138	197	148
17	M	M	S	4	11	135	178	146	48	M	M	S	5	4	138	182	147
18	M	M	S	5	2	126	186	151	49	M	M	S	5	1	122	192	142
19	D	M	S	4	11	127	181	144	**50**	M	M	C	5	3	128	180	150
20	D	M	S	5	5	134	191	153	51	D	D	S	5	7	143	189	150
21	...	M	S	5	3	132	189	148	52	...	D	S	5	2	131	192	146
22	D	D	S	5	1	130	174	149	53	R	M	S	4	11	130	188	147
23	F	L	S	5	1	128	180	144	54	M	D	S	5	4	126	184	144
24	M	M	S	4	9	130	188	144	**55**	M	M	S	4	10	124	186	140
25	D	M	S	5	5	137	176	150	56	D	M	S	5	0	129	187	146
26	...	M	S	5	2	123	183	142	57	M	M	S	5	5	127	183	146
27	D	M	S	5	3	127	185	145	58	D	D	S	5	1	133	184	149
28	...	M	C	4	11	127	189	151	59	...	D	S	5	3	131	192	154
29	D	D	S	5	1	127	181	149	**60**	D	M	S	4	10	125	191	149
30	M	D	S	5	2	132	178	143	61	D	M	S	5	6	133	193	152
31	M	M	S	5	4	125	182	149	62	D	D	S	5	2	129	190	153

IX.—Elgin District Asylum.

FEMALES.									FEMALES.								
1	D	D	S	5	0	125	196	148	21	M	M	S	4	10	126	186	141
2	D	M	S	5	8	131	183	149	22	..	M	S	5	0	127	185	143
3	D	D	S	5	1	126	184	147	23	M	M	S	5	2	134	191	144
4	R	M	S	5	3	132	181	145	24	D	M	C	5	2	131	179	149
5	D	M	S	5	3	125	182	145	**25**	M	M	S	5	2	134	190	158
6	D	M	S	5	3	130	181	144	26	D	D	S	5	2	138	188	141
7	D	M	S	5	5	126	183	142	27	M	M	S	5	3	117	183	144
8	R	M	S	5	4	136	190	146	28	F	L	S	4	11	125	175	138
9	D	M	S	5	0	132	189	149	29	M	D	S	5	5	132	179	144
10	F	M	S	...		119	192	152	**30**	M	M	S	4	10	128	190	147
11	...	M	S	...		128	180	143	31	R	M	S	5	1	126	190	149
12	...	M	S	...		131	193	146	32	D	M	C	4	11	123	187	139
13	...	M	S	...		140	196	156	33	R	M	S	5	1	133	186	141
14	D	M	S	...		127	189	141	34	..	M	W	5	4	119	172	141
15	D	M	S	...		129	183	149	**35**	D	M	S	5	2	136	188	150
16	D	D	C	5	2	131	181	142	36	D	M	S	5	3	123	182	143
17	D	D	S	5	0	137	187	150	37	...	M	S	5	1	125	188	145
18	M	D	C	5	4	137	191	154	38	M	M	S	4	11	125	189	149
19	D	M	S	5	2	136	184	147	39	...	D	S	4	11	131	183	142
20	...	M	S	5	0	134	187	142	**40**	D	D	S	5	3	135	189	151

IX.—Elgin District Asylum.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
41	D	M	S	5	5	131	181	143	66	D	M	S	4	11	129	179	142
42	F	L	S	5	7	132	188	149	67	D	M	S	5	1	121	171	135
43	...	M	S	5	6	135	200	146	68	D	M	S	5	0	124	184	148
44	D	M	S	5	2	123	186	139	69	D	M	S	5	2	128	188	145
45	D	M	S	5	1	128	183	144	**70**	...	D	S	5	7	129	190	151
46	M	M	C	5	0	126	180	143	71	D	M	S	4	9	124	182	150
47	...	D	S	5	1	129	180	144	72	D	M	C	5	5	136	195	145
48	M	M	C	5	6	132	184	142	73	...	M	R	4	9	129	178	139
49	D	M	C	5	0	135	180	148	74	R	M	S	5	1	127	179	146
50	D	M	S	5	6	131	187	145	**75**	R	L	S	5	1	122	182	145
51	D	M	S	5	0	137	197	155	76	D	M	S	5	0	127	186	144
52	R	M	S	5	6	127	188	146	77	M	M	S	5	2	130	186	144
53	D	D	S	5	3	119	183	148	78	...	D	S	4	11	129	185	145
54	D	D	S	5	2	129	189	150	79	...	M	C	5	3	119	169	129
55	D	M	S	5	2	136	184	153	**80**	...	M	S	5	1	129	195	144
56	D	M	S	5	2	117	176	145	81	D	M	S	5	5	127	184	143
57	R	M	S	5	5	134	188	147	82	...	M	C	5	2	131	200	149
58	D	M	S	5	3	123	182	148	83	M	M	C	5	0	123	181	148
59	D	M	S	5	5	120	180	144	84	D	M	S	5	3	118	183	146
60	D	D	S	5	5	134	191	148	**85**	D	M	C	4	10	131	184	143
61	D	M	S	5	6	130	185	158	86	R	M	S	5	1	134	173	144
62	D	M	S	5	6	130	184	155	87	...	M	C	5	8	128	177	139
63	...	D	S	5	3	125	173	146	88	...	D	C	5	1	126	184	142
64	D	M	S	4	10	123	179	142	89	...	M	S	4	11	115	177	139
65	D	M	S	5	5	136	184	147									

X.—Fife District Asylum.

FEMALES.									FEMALES.								
1	M	L	J	4	11	135	186	148	26	M	L	S	5	0	128	190	143
2	M	D	S	5	2	129	182	149	27	M	L	C	5	4	130	189	145
3	M	M	W	5	6	133	189	142	28	D	M	S	5	0	126	182	152
4	M	L	S	5	3	134	187	148	29	D	L	S	5	2	122	191	141
5	M	L	S	4	9	134	177	149	**30**	M	L	S	5	1	126	185	148
6	M	L	S	5	1	123	179	141	31	M	M	S	5	4	137	200	154
7	D	L	S	5	3	130	182	144	32	M	L	S	4	11	125	189	139
8	M	D	S	5	0	125	180	139	33	M	D	S	5	6	125	190	153
9	M	L	S	5	2	126	184	144	34	M	M	S	5	2	126	183	145
10	D	L	J	5	3	125	181	142	**35**	M	M	S	5	3	131	190	138
11	M	L	S	5	1	121	167	141	36	F	M	S	5	4	124	185	145
12	D	L	S	5	4	137	197	160	37	M	D	C	5	3	128	183	143
13	M	D	S	5	1	136	196	144	38	M	M	S	5	3	126	187	140
14	M	L	W	5	1	127	179	144	39	M	L	S	5	4	128	185	144
15	D	D	S	5	2	129	186	141	**40**	M	M	S	5	5	139	196	156
16	M	L	W	4	11	128	188	151	41	M	M	S	5	1	130	193	151
17	M	L	S	5	1	123	182	145	42	M	L	W	4	7	134	183	147
18	M	L	S	4	10	124	184	144	43	M	M	S	5	2	138	194	147
19	M	L	W	5	4	125	181	144	44	D	D	S	5	0	126	178	142
20	M	D	S	5	2	129	188	147	**45**	M	L	W	5	2	128	191	140
21	M	L	W	4	11	131	190	142	46	M	M	S	5	2	122	184	137
22	M	L	S	5	3	128	191	149	47	M	L	S	5	0	122	184	146
23	D	M	S	5	3	132	187	151	48	D	D	S	5	1	124	190	148
24	M	D	S	5	0	127	183	141	49	M	M	S	5	0	128	188	143
25	M	L	S	5	1	129	184	144	**50**	M	M	S	5	4	136	189	151

X.—Fife District Asylum.

FEMALES.

No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
51	D	D	S	5	4	138	189	152
52	M	L	S	5	2	126	179	149
53	M	M	S	5	5	131	185	141
54	M	L	S	5	4	133	186	145
55	M	D	S	5	2	130	184	142
56	D	D	C	5	5	130	191	154
57	M	L	S	5	5	131	195	153
58	M	M	S	5	4	128	180	144
59	M	L	S	5	1	120	173	142
60	M	M	S	5	0	136	192	147
61	M	L	S	5	2	135	190	147
62	M	L	S	5	3	126	190	142
63	M	D	C	4	9	125	186	150
64	M	L	S	5	0	134	189	151
65	M	L	S	4	11	128	183	145
66	M	M	S	5	4	135	185	154
67	M	D	S	5	1	135	178	146
68	M	L	S	5	7	134	193	145
69	M	L	S	5	4	130	195	144
70	M	L	S	5	0	131	185	137
71	M	L	S	5	5	132	183	138
72	D	D	S	5	4	127	194	147
73	D	L	S	5	2	129	189	139
74	F	L	S	5	5	130	185	138
75	M	D	S	5	2	127	187	149
76	M	D	S	5	3	127	179	142
77	M	M	S	4	11	132	180	150
78	M	L	S	5	3	135	186	145
79	D	L	W	5	3	130	185	147
80	M	L	S	5	0	127	190	144
81	D	D	S	5	6	125	179	140
82	D	D	S	5	0	128	181	143
83	M	L	W	5	2	132	196	152
84	M	L	S	5	3	130	184	143
85	M	D	S	5	1	134	185	148
86	M	M	W	5	3	126	189	150
87	D	L	S	5	2	141	196	163
88	M	D	S	5	3	131	183	140
89	M	L	S	4	11	137	192	140
90	D	L	S	5	0	138	183	145
91	D	M	S	5	2	130	198	148
92	M	L	S	4	11	133	178	144
93	M	L	W	5	1	129	185	145
94	D	M	C	5	2	127	176	134
95	M	M	S	5	2	136	182	143
96	M	D	S	5	0	125	177	145
97	M	L	S	5	2	128	188	147
98	D	M	S	5	6	130	207	153
99	D	L	S	4	11	128	190	140
100	M	L	S	5	4	136	186	147
101	D	L	S	5	0	130	181	143
102	D	D	S	5	4	130	182	145
103	M	D	S	5	6	130	199	152
104	M	L	S	5	6	125	192	148
105	D	M	S	5	4	125	181	145
106	D	L	S	4	9	130	189	151
107	M	D	S	4	8	129	183	145
108	M	L	S	5	3	131	187	145
109	M	L	S	5	4	127	189	145
110	D	D	S	4	11	134	202	162
111	M	L	S	5	3	131	190	146
112	M	M	S	5	3	131	196	147
113	M	L	S	5	0	131	195	151
114	D	D	S	5	3	134	188	152
115	M	L	S	5	0	133	192	153
116	M	M	S	4	11	130	194	147
117	M	D	S	4	8	128	192	145
118	M	D	S	5	3	131	190	145
119	M	M	S	5	4	129	182	141
120	M	L	W	5	0	135	185	149
121	M	D	S	4	9	116	178	134
122	D	L	S	5	0	117	177	140
123	D	D	S	5	5	137	193	149
124	M	D	W	5	2	134	193	151
125	M	M	S	5	4	124	187	150
126	M	D	W	5	0	127	187	148
127	M	L	S	5	4	135	192	144
128	M	D	S	5	4	124	186	145
129	M	M	S	5	4	134	200	154
130	M	L	S	4	11	134	194	147
131	M	L	C	5	3	132	181	138
132	D	D	S	4	9	126	185	147
133	D	M	S	5	8	136	184	154
134	M	L	S	5	1	130	191	143
135	D	D	S	5	2	125	181	143
136	D	M	W	5	1	124	179	141
137	M	M	W	4	11	126	188	147
138	D	M	S	5	3	124	185	136
139	M	D	S	5	0	126	175	146
140	D	D	S	5	5	138	195	140
141	M	D	W	5	1	128	192	145
142	M	L	S	5	3	125	190	150
143	M	L	S	4	9	126	179	146
144	M	M	S	5	1	123	181	142
145	M	M	S	5	0	138	192	149
146	M	D	S	4	9	127	183	138
147	M	L	S	5	0	128	178	144
148	D	D	S	4	10	127	187	141
149	M	L	S	5	0	128	188	150
150	D	L	C	5	4	131	188	148
151	M	L	S	5	3	131	183	140
152	M	L	S	5	3	132	193	148
153	D	D	S	5	1	129	185	148
154	M	L	S	4	9	123	193	148
155	D	D	S	5	0	137	193	142
156	D	D	S	5	2	128	194	148
157	M	L	S	4	11	138	188	152
158	M	L	W	5	1	133	192	150
159	M	L	S	5	0	136	184	140
160	D	D	S	5	4	134	182	146
161	M	L	S	5	1	135	186	145
162	M	D	S	5	1	126	186	142
163	D	M	S	5	0	128	186	149
164	M	M	S	4	11	128	194	145
165	M	M	S	5	1	131	177	149
166	M	L	W	5	1	124	182	142
167	R	L	S	4	1	125	178	145
168	M	M	S	4	10	138	195	145
169	M	M	S	5	4	143	202	162
170	M	M	S	5	2	138	186	145

X.—Fife District Asylum.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
171	D	L	W	5	5	137	196	150	191	M	L	S	5	3	127	152	127
172	M	L	S	5	1	127	188	147	192	D	L	S	5	2	131	187	147
173	M	L	S	4	11	127	191	155	193	M	L	S	5	3	135	194	144
174	M	L	S	5	5	124	183	133	194	M	L	S	5	1	123	185	138
175	M	L	S	5	3	134	184	145	**195**	M	L	S	5	0	140	195	155
176	D	L	S	5	0	128	176	134	196	F	M	S	5	2	134	198	152
177	M	D	C	5	0	127	183	147	197	M	M	S	5	0	127	191	141
178	M	D	S	5	2	128	189	153	198	M	L	W	5	0	124	183	146
179	D	M	S	5	0	130	187	145	199	M	M	W	5	3	124	187	148
180	M	L	S	4	11	130	192	146	**200**	M	L	S	5	3	130	180	143
181	D	D	R	5	2	128	188	153	201	M	L	S	5	0	128	182	139
182	M	L	S	5	2	132	151	132	202	M	L	S	4	11	130	182	145
183	M	L	S	5	1	128	187	140	203	M	M	S	5	4	134	194	149
184	M	M	S	4	10	123	180	138	204	M	M	S	5	3	124	179	133
185	M	L	S	5	2	121	184	142	**205**	F	L	S	5	2	132	189	147
186	M	D	...	5	3	125	199	153	206	M	M	S	5	3	133	195	148
187	M	D	W	4	10	124	185	145	207	D	D	S	5	6	134	195	153
188	D	L	S	5	0	123	184	138	208	M	L	S	5	0	134	184	141
189	M	L	S	5	2	124	188	148	209	M	M	S	5	2	128	183	148
190	M	M	S	4	11	127	190	152									

XI.—Glasgow District Asylum (Gartloch).

FEMALES.									FEMALES.								
1	D	M	S	4	8	131	190	141	31	D	L	W	4	8	125	187	153
2	M	L	S	4	9	127	193	138	32	M	M	S	5	0	126	185	142
3	M	M	C	4	10	128	188	144	33	D	D	S	5	4	128	194	154
4	D	L	S	5	4	128	180	147	34	M	L	S	5	2	129	190	141
5	F	L	S	4	10	133	192	146	**35**	M	D	W	5	7	126	183	147
6	M	L	S	5	1	125	165	133	36	M	D	S	5	0	127	180	142
7	M	L	C	4	11	122	189	135	37	D	M	S	5	2	131	179	140
8	M	L	S	5	0	128	187	141	38	M	L	S	5	1	127	181	140
9	D	D	S	5	1	130	190	139	39	M	M	S	5	2	140	183	144
10	D	D	S	5	2	128	186	139	**40**	M	L	S	4	11	129	179	134
11	D	L	S	5	2	127	178	137	41	M	L	C	4	11	119	178	138
12	M	L	C	4	7	135	179	136	42	M	D	S	5	1	124	186	140
13	M	M	S	5	3	130	191	146	43	M	D	S	5	2	125	183	146
14	M	D	S	4	11	125	179	141	44	M	M	W	5	0	127	169	138
15	M	M	S	5	4	128	186	144	**45**	M	L	S	5	3	129	185	146
16	M	M	S	4	11	122	179	144	46	M	L	S	5	4	134	188	144
17	D	D	S	4	11	125	184	147	47	M	M	S	5	2	133	190	146
18	D	M	S	5	3	120	184	135	48	M	D	S	5	5	129	189	139
19	M	D	C	4	2	120	184	136	49	D	D	S	5	2	129	183	147
20	M	D	S	5	1	126	188	146	**50**	M	L	W	5	3	128	183	144
21	M	L	S	5	1	124	180	141	51	M	L	C	4	10	128	184	142
22	M	M	S	5	1	130	185	146	52	M	L	S	5	2	135	193	154
23	M	L	S	5	0	129	188	146	53	M	L	S	5	0	130	181	141
24	M	D	S	5	9	126	182	142	54	M	L	S	4	10	131	187	151
25	M	L	S	4	9	134	196	148	**55**	M	L	J	4	9	130	182	144
26	M	L	S	4	11	134	182	149	56	D	M	S	5	0	129	183	143
27	M	L	S	4	10	128	182	143	57	D	D	S	4	10	127	183	135
28	D	...	S	5	0	136	196	148	58	M	L	S	4	2	133	187	146
29	M	L	S	4	9	122	174	136	59	D	M	S	5	2	126	185	142
30	M	M	S	4	7	117	166	140	**60**	F	L	S	5	3	128	180	146

XI.—Glasgow District Asylum (Gartloch).

FEMALES.

No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
61	M	M	S	5	2	128	185	148
62	M	D	C	5	3	125	187	151
63	F	M	S	4	11	125	186	142
64	M	M	S	4	11	123	185	143
65	M	L	S	5	1	127	186	142
66	M	L	S	5	5	126	191	140
67	D	...	S	4	11	124	181	149
68	M	L	S	5	3	132	188	144
69	M	D	S	5	1	127	191	145
70	M	D	S	4	11	125	186	144
71	M	L	S	5	0	147	198	151
72	D	L	S	5	1	133	194	151
73	D	M	S	4	10	128	186	141
74	M	L	W	5	1	128	185	140
75	M	M	S	5	5	134	189	148
76	D	...	S	5	0	128	183	140
77	D	M	S	4	9	127	183	142
78	M	L	S	5	0	130	183	141
79	M	L	S	5	0	130	194	152
80	M	L	S	4	11	129	189	147
81	D	L	S	4	9	123	170	138
82	M	M	S	5	4	133	193	153
83	M	D	S	5	4	133	196	149
84	M	M	S	5	1	131	188	144
85	M	L	S	4	10	127	190	149
86	M	L	W	4	7	126	183	141
87	M	M	S	4	11	120	176	140
88	D	L	S	5	5	127	187	146
89	M	M	S	4	10	128	187	152
90	M	L	S	5	1	134	184	142
91	D	D	S	5	2	129	189	148
92	M	M	S	4	8	128	181	141
93	M	M	S	5	2	132	180	141
94	D	L	S	5	3	140	194	161
95	M	D	S	5	0	132	179	147
96	M	L	S	4	9	122	180	139
97	M	L	S	4	11	121	191	143
98	M	L	S	5	2	128	185	142
99	M	D	S	4	11	135	200	145
100	M	...	...	5	3	136	203	154
101	M	L	S	5	2	133	183	148
102	R	D	S	4	5	127	183	140
103	M	L	S	5	2	128	184	140
104	M	M	S	4	9	129	181	148
105	M	L	S	5	0	121	181	144
106	M	D	S	5	2	134	185	147
107	M	D	S	5	1	135	190	140
108	D	M	S	4	10	131	186	144
109	M	L	S	5	1	129	186	147
110	M	M	S	4	11	128	181	151
111	D	...	W	5	4	135	190	146
112	M	L	C	5	0	128	188	145
113	M	L	S	5	3	127	188	141
114	F	L	C	4	10	126	178	137
115	M	M	S	5	6	132	182	136
116	M	M	S	4	10	122	184	143
117	M	M	S	5	1	126	189	142
118	D	D	S	5	1	130	183	144
119	M	L	S	5	2	127	182	144
120	D	L	S	5	2	136	188	148
121	M	L	S	5	3	136	185	142
122	M	L	S	5	2	119	181	138
123	M	M	S	4	10	130	171	147
124	D	D	S	5	1	122	182	140
125	M	D	S	5	3	123	183	141
126	M	D	S	4	9	123	189	147
127	M	M	W	5	1	128	183	145
128	F	L	S	5	2	126	183	142
129	D	L	S	4	10	108	172	144
130	M	D	W	5	1	123	185	145
131	M	M	W	4	10	127	182	146
132	M	M	C	5	7	130	181	140
133	M	L	S	5	3	129	190	145
134	D	L	W	5	1	131	181	139
135	M	M	S	4	9	128	190	146
136	M	L	C	4	11	131	189	147
137	M	L	S	5	0	133	187	142
138	M	L	S	4	10	127	185	144
139	D	L	S	5	0	134	189	149
140	M	L	S	5	0	128	188	145
141	M	L	S	5	2	127	190	149
142	M	M	S	4	10	127	183	140
143	F	L	S	5	1	128	182	142
144	M	D	S	5	0	133	184	144
145	M	D	S	5	0	126	191	152
146	M	L	S	5	4	126	193	144
147	M	L	S	4	11	121	193	143
148	M	D	W	5	1	133	195	149
149	D	D	S	4	11	135	191	150
150	M	L	S	5	4	134	189	145
151	M	L	S	5	6	129	190	145
152	M	L	S	5	2	127	185	146
153	D	M	W	5	7	133	184	144
154	M	D	S	4	10	133	191	146
155	D	D	W	5	4	128	189	139
156	M	L	S	5	3	126	202	150
157	M	M	S	5	1	138	196	154
158	D	M	W	5	3	136	192	142
159	D	L	S	4	7	114	180	135
160	M	L	S	5	7	130	180	147
161	D	D	S	4	11	128	182	145
162	M	L	S	5	0	122	177	140
163	M	L	S	5	8	126	179	136
164	M	L	S	5	0	133	181	146
165	M	L	S	4	9	122	185	140
166	F	L	S	5	5	132	185	138

XII.—Glasgow District Asylum (Lenzie).

FEMALES.									FEMALES								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
1	M	M	S	5	0	138	181	151	61	D	L	S	4	10	137	189	143
2	M	L	S	4	10	137	195	143	62	M	L	S	5	3	131	184	152
3	M	L	S	5	3	138	190	146	63	D	M	S	4	10	134	187	144
4	M	L	S	4	7	131	191	151	64	D	M	S	4	10	133	176	147
5	M	M	S	5	2	129	190	145	**65**	M	L	C	4	10	128	182	139
6	M	M	C	5	1	124	187	143	66	M	L	S	4	10	132	190	149
7	M	D	S	5	5	136	190	148	67	D	D	S	5	5	133	188	149
8	M	M	S	4	11	138	188	137	68	D	L	S	5	0	128	177	142
9	D	D	S	4	10	137	187	149	69	M	L	S	5	2	128	180	140
10	D	D	S	4	7	129	184	142	**70**	M	M	S	4	10	130	189	146
11	M	L	W	5	1	134	191	148	71	D	M	S	5	0	134	192	146
12	M	D	S	5	2	134	182	145	72	D	M	S	4	2	129	187	138
13	M	M	S	5	2	138	189	149	73	M	D	W	5	4	133	197	152
14	M	M	S	5	1	135	201	151	74	M	L	S	4	9	130	196	144
15	M	M	S	5	0	130	187	145	**75**	M	L	S	5	1	136	198	144
16	D	D	S	4	0	127	184	141	76	M	L	S	5	1	127	183	142
17	M	L	S	5	0	125	187	146	77	M	L	S	4	9	124	191	150
18	M	L	S	5	1	135	189	151	78	M	D	C	4	10	123	188	142
19	M	D	S	5	1	130	187	147	79	D	D	S	4	9	133	183	141
20	D	L	S	5	2	124	184	143	**80**	D	D	S	5	0	132	192	143
21	M	L	S	5	0	128	181	142	81	D	D	S	5	2	134	191	146
22	M	L	S	5	0	129	180	144	82	D	L	S	5	0	128	182	141
23	M	L	C	5	0	130	194	147	83	D	D	S	5	2	133	188	139
24	M	M	S	5	2	132	187	145	84	D	M	S	4	11	128	181	138
25	M	M	S	4	10	127	179	141	**85**	M	D	S	5	6	138	185	145
26	M	M	S	4	10	128	183	144	86	M	L	S	5	2	129	189	150
27	D	D	S	5	0	129	189	151	87	M	L	C	4	8	131	191	145
28	R	M	S	5	2	131	192	139	88	D	L	S	4	8	132	191	142
29	D	D	C	5	3	133	181	141	89	M	L	S	5	1	128	184	147
30	M	L	W	4	11	129	187	145	**90**	M	L	S	5	1	130	184	146
31	M	L	S	5	2	128	193	152	91	M	D	S	4	11	128	186	146
32	M	D	S	4	8	126	177	143	92	D	M	S	5	1	140	194	155
33	M	M	S	5	4	131	191	145	93	D	L	S	5	8	140	199	146
34	D	D	S	4	10	128	178	143	94	M	D	S	5	0	127	179	141
35	D	M	W	5	2	129	188	147	**95**	M	L	C	4	10	128	181	147
36	M	L	S	5	3	125	187	155	96	M	D	S	4	9	120	176	134
37	M	L	S	5	0	132	191	147	97	M	L	C	4	11	130	183	148
38	M	D	S	5	1	133	187	148	98	M	D	S	5	3	126	185	142
39	D	L	S	5	4	134	193	150	99	M	D	S	5	3	132	200	147
40	D	M	S	5	0	128	184	139	**100**	M	D	S	4	11	132	180	131
41	D	M	W	5	1	127	194	148	101	M	D	S	5	0	133	178	142
42	M	M	S	5	1	127	186	141	102	M	M	S	5	5	142	196	155
43	D	L	S	5	3	135	186	139	103	M	L	S	4	7	132	180	141
44	M	M	R	5	1	134	181	140	104	M	L	S	5	1	124	182	136
45	D	D	S	5	1	133	187	143	**105**	M	L	S	5	1	129	186	146
46	M	L	S	5	2	136	190	145	106	D	M	W	5	0	133	191	141
47	D	L	S	4	10	132	189	144	107	M	D	S	4	11	126	190	150
48	D	M	S	5	2	133	188	141	108	D	D	S	4	3	128	178	141
49	D	M	S	5	0	136	200	147	109	D	M	S	4	11	135	191	149
50	M	L	S	5	1	132	183	144	**110**	D	D	S	5	2	133	185	145
51	D	M	S	5	1	132	180	138	111	M	L	S	4	10	127	186	143
52	D	L	W	5	2	130	188	148	112	M	L	S	5	1	123	193	145
53	M	L	S	5	1	131	184	136	113	M	L	S	5	0	129	191	148
54	D	M	S	5	0	128	190	150	114	M	D	W	4	11	129	190	153
55	D	L	S	5	0	130	191	145	**115**	M	L	S	5	0	126	186	133
56	M	D	S	5	1	131	191	144	116	M	M	S	4	11	132	189	147
57	F	M	S	4	9	125	187	136	117	M	L	S	4	10	123	185	140
58	M	L	S	5	3	137	196	146	118	M	D	S	5	1	128	193	144
59	D	M	S	5	3	133	188	145	119	M	D	S	5	7	141	190	148
60	M	L	S	5	3	136	189	146	**120**	M	D	S	4	5	126	185	143

XII.—Glasgow District Asylum (Lenzie).

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.	Cranial Character.				No.	Colour Character.		Shape of Nose.	Stature.	Cranial Character.			
	Hair.	Eyes.		ft. in.	H. mm.	L. mm.	B. mm.			Hair.	Eyes.		ft. in.	H. mm.	L. mm.	B. mm.	
121	M	D	S	4 11	140	199	140		181	D	M	S	5 3	136	195	147	
122	D	D	C	4 11	140	190	152		182	D	L	S	5 1	138	187	146	
123	M	L	S	4 9	127	188	143		183	D	M	S	4 11	133	174	144	
124	M	L	S	5 0	137	182	147		184	D	L	S	5 0	130	179	143	
125	M	M	S	4 6	124	180	148		**185**	D	L	S	4 11	123	192	147	
126	M	L	C	5 2	129	192	153		186	M	L	S	5 1	134	185	145	
127	D	D	C	5 1	133	190	143		187	M	M	W	4 11	133	180	147	
128	M	L	S	5 2	131	192	154		188	D	D	W	5 1	135	188	146	
129	M	M	S	4 10	134	183	144		189	M	L	S	5 1	134	189	144	
130	D	M	S	5 1	134	178	144		**190**	M	D	W	4 11	124	175	142	
131	D	D	S	5 0	139	184	143		191	M	M	C	5 0	125	178	141	
132	D	D	S	5 1	138	184	147		192	D	M	S	5 0	123	185	138	
133	D	L	S	5 5	135	184	150		193	M	D	S	4 11	136	188	145	
134	M	M	C	5 2	136	190	150		194	M	D	S	5 3	127	184	146	
135	M	D	S	5 1	125	185	144		**195**	D	M	C	5 2	131	195	151	
136	D	L	S	4 10	136	176	145		196	D	L	S	5 2	129	177	149	
137	M	L	S	4 11	127	183	143		197	D	D	S	4 10	124	179	136	
138	D	D	S	5 0	130	178	144		198	D	M	S	5 5	121	186	146	
139	D	D	S	4 9	130	178	139		199	M	M	S	5 0	120	177	136	
140	D	D	S	4 8	129	180	138		**200**	M	M	S	4 9	134	192	146	
141	M	L	S	5 1	124	188	143		201	D	L	C	5 0	127	188	143	
142	M	L	W	5 1	140	197	150		202	D	M	W	4 10	128	188	147	
143	D	D	S	5 2	135	196	146		203	D	D	S	5 0	127	181	137	
144	M	L	S	5 2	133	192	150		204	D	D	S	4 7	126	182	139	
145	M	D	S	5 2	135	200	148		**205**	M	L	S	5 2	134	189	139	
146	M	M	S	4 11	136	183	142		206	M	D	S	5 3	133	189	150	
147	D	M	S	4 10	140	179	143		207	D	D	S	4 10	125	186	140	
148	D	L	S	5 1	128	183	143		208	M	M	C	4 10	129	175	146	
149	D	L	S	5 3	123	190	145		209	D	L	S	5 1	131	193	147	
150	D	L	C	5 2	141	194	149		**210**	M	D	W	4 11	127	182	146	
151	M	D	S	4 9	130	177	148		211	M	D	W	5 0	123	184	137	
152	M	L	S	5 2	129	187	142		212	M	M	S	4 1	129	181	138	
153	D	D	S	5 7	123	195	150		213	D	M	S	4 11	136	185	144	
154	D	D	S	5 3	129	184	141		214	M	L	S	4 4	113	172	137	
155	M	D	S	5 5	127	175	138		**215**	D	M	S	4 11	128	184	147	
156	M	D	S	5 1	141	202	143		216	F	L	C	4 11	135	181	145	
157	M	L	S	5 6	134	190	147		217	M	M	S	5 0	129	195	145	
158	M	M	S	4 10	137	197	150		218	M	L	S	5 3	133	185	144	
159	D	D	S	4 11	134	189	145		219	M	M	S	4 9	132	184	136	
160	M	M	C	5 5	136	183	149		**220**	D	M	W	5 1	131	189	145	
161	M	M	C	4 11	133	187	144		221	M	M	S	4 9	123	191	152	
162	R	D	S	4 10	133	188	149		222	D	D	S	5 2	136	177	135	
163	D	L	W	5 3	130	180	146		223	M	D	S	4 11	143	193	152	
164	M	M	C	5 2	128	186	146		224	M	L	S	5 1	125	188	148	
165	M	M	C	5 3	130	188	148		**225**	M	M	S	5 7	128	186	142	
166	M	L	S	5 0	121	188	145		226	D	L	S	5 1	137	194	135	
167	M	L	S	5 3	136	185	144		227	D	D	S	5 0	130	186	144	
168	M	L	S	5 2	134	191	143		228	M	M	S	4 1	136	186	149	
169	M	D	S	4 9	134	184	146		229	M	L	S	4 10	135	187	146	
170	M	L	S	5 0	135	188	142		**230**	D	M	S	5 0	130	181	141	
171	D	D	S	5 5	139	191	150		231	M	M	S	5 0	129	179	144	
172	M	L	S	5 1	133	192	146		232	M	L	S	4 11	124	190	142	
173	D	D	C	5 3	134	183	148		233	M	L	R	5 4	124	184	144	
174	D	L	S	5 0	139	189	144		234	M	L	S	4 11	123	183	144	
175	M	D	C	4 10	127	178	138		**235**	F	L	S	4 10	123	182	135	
176	M	D	S	4 11	129	177	142		236	D	D	S	5 1	123	185	142	
177	M	L	S	4 11	138	196	145		237	D	D	C	4 11	127	179	144	
178	D	M	S	4 11	126	189	145		238	D	D	S	5 3	127	183	142	
179	M	L	S	4 8	125	183	144		239	M	L	W	5 2	129	187	145	
180	M	M	S	5 1	140	201	151		**240**	D	M	S	4 10	128	184	144	

XII.—Glasgow District Asylum (Lenzie).

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
241	D	D	S	4	11	126	190	146	263	M	M	S	5	1	131	184	150
242	D	D	S	4	6	131	173	136	264	M	M	C	4	11	134	185	137
243	M	M	C	5	0	127	189	142	**265**	D	L	C	4	8	137	182	146
244	M	L	S	4	10	123	187	146	266	D	D	S	4	10	136	186	144
245	M	M	S	5	1	130	185	142	267	D	D	S	5	1	127	186	152
246	M	M	S	4	8	123	177	141	268	D	L	S	5	0	133	181	141
247	D	D	S	4	0	125	186	142	269	D	M	S	5	1	124	183	142
248	D	D	S	5	1	129	186	142	**270**	D	M	S	5	1	120	178	146
249	M	L	S	5	1	127	183	137	271	D	D	C	5	0	124	184	146
250	D	M	W	5	2	132	187	148	272	M	M	S	5	2	118	184	145
251	M	M	W	5	1	128	190	142	273	D	D	S	5	2	134	185	137
252	M	L	S	5	1	129	186	138	274	M	L	S	5	1	128	183	150
253	D	L	S	5	1	125	182	143	**275**	M	D	S	5	2	136	188	147
254	M	D	S	5	0	133	195	148	276	M	D	S	5	3	130	185	149
255	D	M	S	5	3	136	191	149	277	M	D	S	4	10	130	190	147
256	M	L	S	4	11	133	171	140	278	D	D	W	5	0	123	183	147
257	D	L	S	5	0	129	184	143	279	M	M	S	5	1	137	189	148
258	D	D	S	5	1	123	191	147	**280**	D	D	S	5	0	123	188	144
259	D	D	S	5	7	127	188	147	281	D	D	S	5	1	136	192	156
260	M	L	S	5	5	128	191	150	282	D	D	S	5	1	132	181	147
261	D	L	S	4	9	123	175	140	283	F	L	S	5	0	124	187	144
262	D	D	S	5	0	131	194	155									

XIII.—Govan District Asylum.

FEMALES.									FEMALES.								
1	M	L	S	5	2	131	189	144	26	M	L	S	5	1	131	195	149
2	D	D	W	5	1	137	181	153	27	D	D	S	6	0	133	197	153
3	D	M	S	4	4	129	168	144	28	M	M	S	5	1	124	179	141
4	D	D	S	4	11	130	178	147	29	M	D	S	5	0	139	185	146
5	M	L	W	5	4	132	193	143	**30**	M	L	W	4	0	136	193	142
6	M	L	S	5	3	130	184	146	31	M	L	S	4	11	132	184	150
7	D	M	S	5	3	131	184	143	32	M	L	C	4	10	130	192	142
8	M	L	S	5	2	130	186	142	33	M	L	S	4	11	128	182	146
9	D	D	S	5	1	129	188	144	34	M	M	C	4	9	132	186	141
10	D	L	S	5	2	135	178	139	**35**	M	L	S	4	11	129	185	149
11	M	L	S	5	4	124	178	146	36	M	D	W	4	11	129	171	145
12	M	L	S	5	0	129	178	147	37	M	L	S	5	0	129	181	145
13	F	L	S	5	0	128	185	145	38	D	D	C	5	3	133	191	147
14	M	D	S	5	2	137	199	154	39	M	M	S	5	2	132	186	139
15	M	L	W	5	0	129	178	136	**40**	M	L	S	5	2	127	185	143
16	D	D	S	5	1	129	179	138	41	M	L	S	4	9	128	179	138
17	M	L	S	5	2	127	177	149	42	M	M	R	4	10	123	181	134
18	M	L	S	5	1	131	185	148	43	M	L	S	4	9	135	192	148
19	M	L	S	5	3	135	195	139	44	M	M	S	5	1	125	181	138
20	M	L	W	4	9	132	177	147	**45**	D	L	S	5	1	132	179	140
21	D	L	S	5	5	132	198	143	46	M	L	W	5	2	131	184	141
22	M	D	S	5	2	135	176	143	47	M	L	W	5	1	127	181	144
23	M	L	S	5	0	130	201	148	48	M	L	S	5	3	132	182	146
24	M	L	C	5	5	138	181	141	49	M	M	W	4	11	133	184	143
25	M	L	S	5	0	137	195	152	**50**	D	D	S	4	10	128	176	142

XIII.—Govan District Asylum.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
51	M	D	C	5	3	131	179	147	111	M	L	S	5	2	135	195	148
52	D	D	S	4	11	125	189	149	112	M	L	R	5	5	135	179	145
53	D	D	S	4	10	128	186	142	113	D	M	S	5	1	135	189	143
54	D	D	C	5	8	139	199	149	114	D	L	S	5	3	129	195	149
55	D	D	S	5	1	130	179	140	115	M	L	S	5	0	129	186	147
56	M	M	S	4	11	120	184	140	116	D	L	S	5	0	140	186	147
57	F	L	W	5	2	121	186	143	117	M	L	S	5	3	135	195	146
58	M	D	S	5	2	132	197	149	118	M	L	S	5	4	128	187	146
59	M	D	S	5	1	127	188	142	119	M	L	S	4	10	128	181	139
60	D	L	S	5	6	135	195	148	120	M	M	S	5	0	131	190	148
61	M	L	S	5	1	133	185	146	121	M	D	C	5	0	135	192	147
62	M	L	S	5	1	126	186	156	122	D	L	S	5	0	131	184	139
63	D	D	S	4	9	123	182	136	123	D	D	S	5	5	139	188	144
64	M	M	S	4	7	131	189	140	124	M	L	S	5	3	136	193	143
65	M	D	S	5	4	128	191	144	125	D	L	S	4	11	135	189	143
66	M	L	S	5	5	133	189	147	126	M	D	S	5	2	138	187	149
67	M	L	S	4	9	130	182	147	127	M	L	S	5	2	130	187	145
68	M	D	S	5	3	132	187	149	128	M	L	S	5	3	130	189	140
69	M	L	S	5	3	135	197	146	129	R	M	S	5	6	142	190	146
70	M	L	S	5	2	131	182	142	130	M	L	S	4	9	136	201	145
71	M	L	W	5	4	130	182	146	131	D	L	S	4	11	129	177	139
72	D	M	S	5	4	131	190	148	132	M	M	S	5	2	133	192	143
73	D	M	S	5	2	137	179	140	133	D	D	S	5	1	130	190	140
74	M	L	S	4	11	130	182	152	134	M	L	W	5	1	134	185	141
75	D	L	W	5	2	133	193	155	135	D	D	S	5	1	134	184	155
76	M	L	C	5	0	135	198	145	136	R	M	S	4	10	137	187	144
77	M	L	S	5	4	129	179	145	137	D	L	W	5	1	135	187	150
78	M	L	S	5	1	130	182	137	138	M	L	S	4	10	129	182	140
79	D	...	S	4	9	133	191	141	139	D	M	S	5	2	127	182	143
80	M	L	S	5	4	135	185	152	140	M	L	S	5	3	136	190	149
81	M	L	S	4	11	133	186	155	141	M	L	S	5	4	137	172	148
82	M	L	S	5	3	125	186	141	142	D	D	C	4	8	134	187	161
83	M	D	S	5	0	124	185	144	143	D	D	S	5	2	132	185	142
84	M	L	S	4	10	140	184	149	144	M	D	S	5	3	125	196	153
85	D	L	S	4	10	125	181	134	145	D	D	S	5	2	141	191	144
86	M	D	S	4	11	125	181	151	146	D	M	S	5	7	138	186	143
87	M	L	S	5	2	136	191	155	147	M	L	S	5	0	133	184	147
88	M	D	S	5	1	133	187	149	148	D	L	S	5	1	132	191	147
89	D	M	S	5	1	127	173	136	149	D	M	S	5	0	132	188	145
90	D	D	S	4	9	131	182	140	150	D	D	S	5	2	131	183	146
91	M	M	S	4	11	130	184	140	151	M	L	S	5	3	131	184	142
92	M	M	S	5	1	133	182	141	152	M	L	S	5	4	129	185	143
93	M	M	S	5	1	137	185	147	153	M	M	S	5	5	123	193	150
94	D	D	S	4	10	131	181	144	154	M	L	S	5	6	144	191	141
95	M	M	S	5	0	131	194	145	155	D	D	S	4	7	129	185	139
96	D	D	S	5	2	131	187	140	156	M	L	S	5	0	128	181	141
97	D	D	S	5	1	135	189	148	157	M	M	S	5	3	124	188	141
98	M	D	S	5	1	135	185	151	158	M	M	S	4	9	129	186	144
99	D	L	S	5	4	133	185	135	159	D	L	S	5	2	131	183	142
100	M	D	S	4	10	127	179	136	160	D	D	S	4	10	131	187	145
101	D	D	S	5	1	133	182	138	161	M	L	S	5	0	133	182	145
102	D	L	S	5	5	133	185	143	162	D	L	W	5	6	131	185	148
103	M	D	S	5	4	134	184	144	163	F	L	S	5	1	126	179	140
104	D	D	S	5	0	133	191	140	164	M	D	S	5	3	126	192	139
105	M	D	S	4	2	133	185	138	165	D	M	S	5	6	132	188	143
106	M	M	S	5	1	124	179	143	166	M	D	S	5	2	129	189	143
107	M	M	S	5	3	145	190	146	167	M	L	W	5	6	130	190	145
108	M	L	S	4	10	125	187	145	168	M	L	S	4	10	127	184	141
109	M	L	S	5	3	131	188	141	169	M	L	S	5	3	133	188	145
110	M	D	S	5	0	130	187	149	170	M	L	S	5	0	128	176	143

XIII.—Govan District Asylum.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.				H.	L.	B.		Hair.	Eyes.				H.	L.	B.
				ft.	in.	mm.	mm.	mm.					ft.	in.	mm.	mm.	mm.
171	M	L	S	5	0	128	184	147	**180**	M	L	S	5	5	135	183	146
172	M	M	S	4	11	127	191	140	181	M	L	S	4	8	126	178	137
173	M	L	S	5	1	133	186	145	182	D	D	S	5	1	136	185	147
174	M	M	S	...		123	179	138	183	M	D	S	5	2	133	190	147
175	M	D	C	5	0	130	192	140	184	M	L	S	4	9	137	189	143
176	D	M	S	5	0	131	192	147	**185**	D	L	S	5	0	133	186	143
177	M	L	S	5	2	133	185	147	286	M	M	S	4	8	140	189	149
178	M	L	S	4	9	129	181	140	287	D	M	S	5	3	129	188	148
179	M	L	S	5	5	136	185	148									

XIV.—Haddington District Asylum.

FEMALES.									FEMALES.								
1	M	L	S	4	10	144	187	138	38	D	D	W	5	3	138	184	146
2	M	L	S	5	0	127	178	136	39	M	L	S	5	4	137	192	143
3	M	L	S	5	3	135	163	149	**40**	M	L	S	5	2	137	189	141
4	M	L	S	5	2	130	181	144	41	M	L	S	5	2	128	182	136
5	M	L	S	5	2	135	186	144	42	D	M	S	5	0	130	184	142
6	D	D	S	5	1	138	189	150	43	R	M	S	5	7	145	183	143
7	M	M	S	5	3	137	186	140	44	D	M	S	4	11	137	185	142
8	D	D	S	5	7	143	185	147	**45**	M	M	S	4	9	135	178	146
9	D	M	W	5	2	134	184	142	46	D	D	S	5	4	135	182	141
10	D	L	S	5	3	139	197	150	47	M	L	S	4	11	121	178	136
11	M	L	S	5	1	129	180	143	48	M	D	S	4	9	127	188	142
12	M	L	S	5	5	141	198	150	49	D	M	S	4	11	135	188	141
13	M	D	S	5	0	141	192	143	**50**	M	L	S	4	9	125	180	142
14	D	D	S	5	1	136	189	146	51	M	D	S	4	9	141	183	151
15	M	D	W	4	11	134	188	150	52	D	D	S	4	9	136	194	155
16	M	M	S	5	0	128	194	149	53	M	L	S	4	11	134	180	136
17	D	D	S	4	11	126	181	138	54	M	D	S	4	11	133	185	145
18	M	D	S	5	1	133	188	144	**55**	M	L	S	5	3	141	176	154
19	D	M	S	5	2	128	178	143	56	M	D	S	4	11	136	192	143
20	M	L	S	5	4	139	183	146	57	M	M	S	5	4	137	176	146
21	D	M	S	5	3	136	193	144	58	D	M	W	5	2	126	176	145
22	M	L	S	5	2	138	184	138	59	M	L	S	5	0	136	192	152
23	D	M	S	5	3	136	191	142	**60**	D	M	S	5	2	131	197	150
24	R	L	S	5	3	130	180	134	61	M	M	C	5	4	141	196	149
25	M	M	S	5	2	138	195	148	62	M	D	S	5	5	146	198	155
26	M	M	S	5	0	123	181	146	63	M	D	S	4	11	131	180	152
27	M	D	W	5	0	134	196	143	64	D	L	S	5	5	135	192	155
28	M	L	S	5	3	129	183	143	**65**	M	L	S	4	11	129	185	145
29	D	D	C	4	10	138	190	144	66	M	D	S	5	1	134	185	155
30	M	L	S	5	7	135	186	146	67	D	D	W	5	6	132	189	140
31	M	L	C	5	0	135	185	142	68	D	M	S	4	9	124	184	139
32	D	M	S	5	6	134	183	143	69	D	M	S	5	1	130	186	147
33	M	L	S	5	2	138	188	140	**70**	D	M	S	5	3	141	202	150
34	M	L	S	5	7	136	195	156	71	M	M	W	5	6	133	178	129
35	D	M	S	5	2	133	185	143	72	M	L	S	5	1	133	184	136
36	M	M	W	5	7	147	200	146	73	D	D	S	5	4	134	188	142
37	M	L	S	5	1	130	185	150	74	D	L	W	5	1	128	180	142

XV.—Inverness District Asylum.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
1	D	D	S	5	1	111	178	141	61	D	M	S	4	11	112	182	143
2	D	D	S	4	11	127	186	143	62	D	M	S	4	10	120	171	139
3	M	M	S	4	9	126	193	144	63	...	M	S	5	6	129	176	147
4	...	M	S	5	0	132	196	149	64	R	D	S	5	0	116	183	145
5	...	M	S	5	4	133	183	138	**65**	...	M	S	5	2	123	192	152
6	D	M	S	4	11	127	187	152	66	...	L	S	...		131	196	153
7	D	D	S	5	2	129	180	139	67	...	L	S	4	11	126	184	145
8	...	M	S	5	0	116	184	144	68	D	D	S	5	5	130	192	150
9	D	M	S	5	1	117	180	141	69	D	D	S	4	11	126	184	148
10	D	D	S	4	11	125	182	145	**70**	D	D	S	5	1	122	191	145
11	D	M	C	5	2	127	186	150	71	D	D	S	...		126	186	142
12	M	M	S	5	1	127	184	142	72	D	D	S	5	2	129	187	144
13	D	M	S	5	6	135	198	150	73	...	D	S	5	0	128	175	144
14	D	D	S	5	1	122	191	148	74	R	D	S	5	2	149	194	151
15	D	D	S	5	0	126	171	139	**75**	...	D	S	4	10	123	186	145
16	...	M	S	4	10	130	192	150	76	...	M	S	5	3	138	197	150
17	R	M	S	5	3	137	180	145	77	D	M	C	5	1	127	190	139
18	D	M	S	5	1	138	192	154	78	...	M	S	4	10	136	188	146
19	...	M	S	5	1	137	189	144	79	D	D	S	5	1	125	187	150
20	D	D	S	5	3	120	186	146	**80**	D	D	S	5	2	131	187	144
21	F	M	S	5	2	120	189	139	81	D	D	S	5	5	132	187	143
22	...	M	S	5	1	129	187	150	82	...	D	S	5	1	139	202	150
23	D	M	S	5	3	120	183	143	83	M	M	S	4	11	131	189	149
24	...	D	C	5	0	126	186	151	84	...	M	S	5	1	124	184	144
25	D	D	S	5	2	122	187	150	**85**	D	M	S	5	0	127	188	141
26	D	M	S	5	1	126	184	149	86	D	M	S	5	4	128	191	149
27	D	M	S	5	3	123	179	144	87	F	L	S	5	1	125	190	149
28	M	M	S	5	2	121	178	137	88	D	D	S	5	3	127	180	143
29	R	L	S	5	2	125	184	142	89	D	M	S	5	2	128	195	153
30	D	M	S	4	11	127	187	151	**90**	D	D	S	5	4	128	189	145
31	M	M	S	4	10	130	198	154	91	D	M	S	5	4	127	184	144
32	M	L	S	5	7	124	180	146	92	D	D	S	5	2	133	181	148
33	D	...	S	5	5	130	187	150	93	M	M	S	5	6	123	191	152
34	D	L	S	5	1	133	181	155	94	D	D	S	5	1	122	179	147
35	D	D	S	5	0	122	193	146	**95**	...	M	S	4	10	134	188	145
36	M	L	S	5	3	132	186	146	96	...	M	S	5	1	127	188	150
37	D	M	S	5	4	124	191	142	97	...	M	S	4	9	127	184	148
38	D	D	S	5	2	130	181	149	98	R	M	S	5	10	138	191	150
39	D	M	S	5	4	114	181	141	99	...	M	S	...		137	191	149
40	D	M	S	5	3	132	191	143	**100**	D	D	S	5	0	128	188	150
41	R	L	S	4	9	122	179	143	101	...	M	S	5	3	126	187	151
42	M	D	S	5	2	128	178	139	102	...	M	S	5	4	126	183	142
43	D	L	S	5	5	132	180	153	103	D	M	S	5	5	135	193	149
44	R	L	S	5	2	137	194	145	104	...	M	S	4	10	133	188	148
45	D	M	S	5	5	135	189	156	**105**	D	M	S	5	3	128	194	144
46	..	D	S	5	1	133	187	151	106	D	D	S	5	3	128	190	153
47	D	D	S	5	2	125	192	148	107	D	D	S	4	10	133	180	145
48	D	M	S	5	1	126	180	142	108	...	M	S	4	9	120	197	144
49	D	M	S	...		129	183	148	109	R	D	S	...		133	194	147
50	F	L	S	5	3	135	194	148	**110**	D	M	S	...		117	181	140
51	..	D	S	5	4	126	188	146	111	...	L	S	5	0	121	188	145
52	D	M	S	5	1	133	194	147	112	R	L	S	5	2	123	189	158
53	M	M	S	5	1	120	183	153	113	D	M	S	5	3	131	187	141
54	R	M	S	5	4	127	191	145	114	F	L	S	4	1	121	191	144
55	D	L	S	5	0	125	188	146	**115**	D	M	S	5	4	126	187	150
56	...	L	S	5	1	120	189	145	116	F	L	S	...		125	182	146
57	...	M	S	4	9	131	187	145	117	D	M	S	5	3	127	188	148
58	M	L	S	5	2	133	193	153	118	D	M	S	5	6	131	183	147
59	...	D	S	5	2	114	175	147	119	D	M	C	5	0	137	186	143
60	M	M	S	5	4	125	189	152	**120**	D	M	S	5	5	135	193	152

XV.—Inverness District Asylum.

FEMALES.								FEMALES.							
No.	Colour Character.		Shape of Nose.	Stature.	Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.	Cranial Character.		
	Hair.	Eyes.		ft. in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft. in.	H. mm.	L. mm.	B. mm.
121	...	D	S	4 11	127	186	140	181	D	M	S	5 0	131	186	149
122	M	L	S	5 3	132	187	153	182	M	M	S	5 3	134	194	148
123	M	L	S	5 4	121	182	144	183	M	M	S	5 5	136	187	143
124	...	L	S	4 10	126	191	152	184	D	M	S	5 3	128	193	142
125	M	L	S	5 1	119	182	140	**185**	..	M	S	5 0	125	179	150
126	D	D	S	5 5	134	190	158	186	R	M	S	5 2	123	190	148
127	D	D	S	5 3	135	191	150	187	...	M	W	5 4	128	184	147
128	M	L	S	5 4	130	196	147	188	R	L	S	5 2	127	177	145
129	F	L	S	5 7	132	199	145	189	F	L	S	5 5	125	185	144
130	...	M	S	5 6	129	190	144	**190**	D	M	S	5 7	134	193	148
131	M	M	S	5 3	128	192	145	191	D	M	S	5 0	131	191	144
132	D	M	S	5 4	139	173	152	192	...	M	S	5 3	131	185	146
133	D	M	S	4 9	120	175	146	193	...	M	C	5 4	130	192	151
134	D	M	S	5 6	134	194	149	194	M	M	S	5 0	125	185	145
135	M	M	S	5 5	132	186	153	**195**	...	L	S	5 1	123	184	147
136	D	M	S	5 1	123	184	146	196	D	M	S	5 4	139	192	148
137	...	M	S	5 5	132	203	151	197	R	M	S	5 4	125	188	150
138	D	D	S	5 7	126	187	146	198	M	M	S	5 4	128	195	144
139	D	M	S	5 3	134	188	144	199	...	L	S	5 1	132	192	138
140	...	M	S	5 2	121	187	144	**200**	D	M	S	4 9	125	189	148
141	D	D	C	5 1	126	189	152	201	M	L	S	5 5	134	185	155
142	D	M	S	5 0	117	179	143	202	R	M	S	5 3	125	187	150
143	D	D	S	5 4	132	187	152	203	...	M	S	5 4	127	191	149
144	M	M	S	5 0	122	180	138	204	...	D	C	5 7	142	190	152
145	M	M	S	5 3	121	189	142	**205**	D	M	S	4 11	117	174	138
146	R	M	S	5 3	124	204	155	206	D	M	S	4 11	118	181	147
147	D	M	C	5 11	115	173	139	207	D	M	S	5 3	130	180	144
148	...	D	S	5 1	122	180	145	208	D	M	S	5 5	128	189	145
149	M	L	S	5 3	128	183	145	209	D	M	C	5 3	137	191	146
150	M	L	S	4 9	123	182	146	**210**	D	M	S	5 2	130	192	150
151	...	D	S	5 1	123	184	141	211	D	M	C	4 11	127	187	137
152	D	M	S	5 7	134	194	151	212	M	L	S	5 0	126	185	141
153	M	M	S	5 2	126	189	153	213	D	M	S	5 0	124	188	147
154	M	M	W	5 1	120	191	140	214	D	D	C	5 4	133	196	154
155	D	D	S	5 5	134	194	147	**215**	D	M	S	5 3	128	192	145
156	...	D	S	5 5	128	189	141	216	D	M	S	4 11	132	194	144
157	...	M	W	...	123	180	145	217	D	D	S	5 5	131	191	153
158	M	D	S	...	124	185	140	218	D	M	S	5 4	128	194	142
159	...	M	S	..	129	191	144	219	D	M	S	4 10	126	189	148
160	...	M	S	5 2	121	180	147	**220**	...	L	C	5 3	127	198	149
161	D	M	S	...	125	190	149	221	D	D	C	4 10	130	183	141
162	...	M	S	...	120	194	154	222	M	M	S	5 4	134	196	148
163	...	M	S	...	126	193	150	223	M	M	S	5 2	128	186	155
164	...	L	S	...	121	195	144	224	D	M	S	4 11	128	187	146
165	M	M	S	...	134	182	146	**225**	D	M	S	5 4	130	176	143
166	D	M	S	...	132	186	151	226	M	L	C	5 5	132	193	145
167	...	M	S	...	132	189	151	227	D	M	S	5 4	135	185	149
168	M	M	S	...	122	182	134	228	D	M	S	5 1	129	183	144
169	...	D	S	...	128	188	143	229	D	M	S	5 4	136	195	149
170	...	M	S	...	119	179	147	**230**	D	M	S	5 1	127	183	147
171	M	M	S	...	125	180	142	231	M	M	S	5 1	128	183	148
172	D	M	C	...	125	187	151	232	...	M	S	5 6	133	199	145
173	D	M	S	...	127	197	153	233	D	D	S	4 10	130	174	142
174	D	D	C	...	127	183	144	234	D	M	C	5 8	125	184	140
175	...	L	S	5 0	131	194	152	**235**	D	M	S	5 3	139	194	149
176	D	M	S	5 3	125	196	155	236	D	D	C	4 11	133	183	148
177	D	M	C	5 1	131	173	135	237	D	M	S	5 2	126	189	146
178	...	M	S	5 3	131	187	148	238	M	M	S	4 10	118	187	140
179	D	D	S	5 1	133	189	148	239	D	M	S	5 2	128	187	146
180	D	D	R	4 11	134	183	148	**240**	...	M	S	4 10	116	179	140

XV.—Inverness District Asylum.

FEMALES.

No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
241	D	M	S	5	0	135	173	143
242	M	M	S	5	2	129	185	147
243	D	M	S	5	2	126	180	146
244	D	M	S	5	2	134	182	152
245	D	M	S	5	5	130	195	148

FEMALES.

No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
246	D	M	S	5	5	137	195	150
247	...	L	S	4	10	128	188	146
248	M	M	S	5	1	130	180	143
249	M	M	S	4	8	131	184	148
250	...	D	S	4	11	139	183	147

XVI.—Lanark District Asylum.

FEMALES.

No.	Hair.	Eyes.	Shape of Nose.	ft.	in.	H. mm.	L. mm.	B. mm.
1	M	L	S	5	1	137	191	151
2	D	L	S	4	11	131	187	142
3	M	M	S	5	1	128	178	143
4	M	L	W	5	2	136	187	151
5	M	L	S	4	10	127	187	147
6	D	L	C	5	1	124	178	136
7	D	M	S	4	9	128	181	151
8	D	M	S	4	11	125	186	148
9	D	M	S	4	11	127	188	148
10	M	M	S	4	9	134	194	142
11	M	L	S	5	3	128	184	139
12	D	D	S	5	3	130	185	142
13	M	L	S	5	4	127	183	141
14	M	M	S	5	1	133	184	142
15	R	L	S	5	0	127	180	144
16	D	L	W	4	10	128	188	145
17	D	M	S	5	3	135	186	140
18	M	L	W	5	6	137	186	145
19	D	M	S	5	5	129	189	142
20	M	L	S	5	2	134	183	152
21	M	L	S	5	2	130	181	143
22	M	D	S	5	0	132	184	151
23	D	D	W	4	11	129	184	136
24	D	D	S	5	0	127	183	147
25	D	L	S	5	3	133	191	137
26	D	D	S	5	1	133	187	144
27	M	L	S	5	5	120	195	139
28	M	L	S	5	4	135	186	142
29	M	M	S	5	3	140	182	147
30	M	D	W	5	1	128	185	145
31	M	L	W	5	1	131	187	138
32	M	L	S	5	1	142	186	151
33	M	D	S	5	0	137	188	148
34	D	M	S	5	0	124	191	151
35	D	L	S	5	7	128	196	151
36	M	L	W	5	1	133	188	142
37	M	M	S	5	6	135	185	149
38	D	D	R	4	8	132	173	142
39	F	L	S	4	10	131	181	146
40	M	L	W	5	4	133	183	140
41	D	M	C	4	9	130	179	143
42	D	D	S	5	0	142	202	151
43	M	M	S	5	3	129	176	139
44	M	L	S	5	1	131	188	149
45	M	L	S	5	1	133	184	142

FEMALES.

No.	Hair.	Eyes.	Shape of Nose.	ft.	in.	H. mm.	L. mm.	B. mm.
46	D	D	S	4	7	133	182	140
47	M	L	S	5	4	137	198	151
48	D	L	S	5	3	136	188	146
49	M	D	S	5	3	143	202	156
50	F	L	R	5	2	139	185	150
51	D	D	W	5	2	133	183	142
52	D	M	S	5	1	130	190	146
53	M	D	C	5	1	134	195	148
54	D	D	S	5	2	131	187	148
55	M	M	S	5	3	139	187	146
56	D	M	S	5	3	131	190	150
57	D	M	S	5	1	131	185	147
58	M	M	S	4	11	133	183	142
59	M	L	S	5	1	137	197	149
60	D	M	C	5	3	139	187	147
61	M	M	S	5	4	136	194	148
62	D	D	S	4	8	122	177	138
63	M	M	S	4	8	123	178	135
64	D	M	W	5	2	121	185	151
65	M	D	S	5	6	146	199	150
66	D	M	S	4	9	142	197	149
67	M	M	C	5	2	128	191	151
68	M	D	S	5	2	131	196	155
69	M	M	S	5	0	132	191	145
70	D	D	S	5	3	132	195	151
71	M	L	S	4	10	135	185	145
72	M	M	S	5	3	127	186	140
73	M	L	S	5	2	139	190	149
74	D	D	W	5	1	133	185	144
75	M	D	S	5	3	135	190	156
76	M	L	C	5	2	131	178	143
77	M	L	S	5	1	123	172	137
78	M	L	W	4	11	122	183	143
79	M	L	S	5	3	134	190	155
80	M	L	S	4	9	129	174	142
81	M	M	S	4	11	131	185	140
82	D	D	W	5	2	135	190	142
83	M	L	S	5	1	132	186	142
84	M	L	W	5	1	137	188	141
85	M	D	S	5	3	139	187	158
86	D	M	S	4	10	139	183	146
87	M	L	S	5	2	127	188	150
88	M	L	S	5	0	135	193	152
89	D	D	C	4	10	129	183	143
90	M	L	S	4	11	127	185	140

XVI.—Lanark District Asylum.

FEMALES.									FEMALES.								
No.	Colour Character		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
91	M	M	S	4	11	128	193	148	151	M	D	S	5	3	149	197	158
92	M	L	S	5	1	129	186	149	152	M	D	S	4	10	133	189	143
93	M	D	S	5	0	131	184	138	153	D	M	S	5	2	130	188	147
94	M	M	S	4	9	131	177	135	154	D	D	S	4	11	126	183	139
95	D	L	S	5	0	126	183	138	**155**	D	M	S	5	1	128	183	142
96	M	M	S	3	10	131	173	138	156	D	D	S	5	4	134	184	142
97	D	L	S	4	11	126	185	146	157	M	L	S	4	3	135	190	143
98	D	D	S	4	11	132	184	147	158	D	D	S	4	11	122	174	135
99	M	L	S	5	3	129	188	141	159	D	M	S	5	1	127	184	145
100	D	D	S	5	0	126	194	147	**160**	D	D	S	5	2	131	193	150
101	D	M	S	5	6	128	194	146	161	M	L	S	5	0	132	183	150
102	M	M	S	5	3	130	190	150	162	D	D	S	5	1	139	188	141
103	M	L	S	5	4	132	189	146	163	D	D	S	5	2	136	185	145
104	M	M	S	5	5	134	189	145	164	D	L	S	5	0	136	182	145
105	D	D	S	4	11	134	187	143	**165**	M	L	S	5	4	127	188	147
106	M	M	S	5	1	127	188	145	166	M	M	W	5	5	136	191	148
107	D	L	W	5	3	135	193	148	167	D	M	W	5	1	130	180	141
108	D	D	S	5	1	138	185	144	168	R	L	S	4	11	133	186	148
109	M	M	S	5	2	129	185	146	169	M	L	S	5	1	144	192	151
110	M	L	S	5	1	134	187	148	**170**	M	L	S	5	1	137	193	142
111	F	L	S	5	6	136	195	145	171	D	L	S	5	1	130	189	149
112	D	D	S	5	6	133	182	143	172	D	D	S	4	11	124	174	140
113	M	L	C	4	11	131	184	144	173	M	L	S	4	11	129	187	142
114	M	L	S	5	1	133	186	146	174	M	D	W	5	2	136	198	151
115	M	L	S	5	2	133	184	141	**175**	M	D	S	4	10	137	196	147
116	M	D	C	5	1	129	188	145	176	M	L	S	4	7	131	185	146
117	M	M	S	5	1	131	180	145	177	M	L	W	5	1	123	190	143
118	R	L	S	4	9	129	186	145	178	F	L	C	5	2	120	170	139
119	D	L	S	5	0	131	182	146	179	M	L	S	5	3	140	198	155
120	D	D	S	4	3	120	161	128	**180**	M	M	W	4	11	139	198	150
121	M	L	S	4	11	138	195	148	181	D	D	S	5	0	140	181	141
122	M	L	W	5	1	137	184	142	182	D	M	S	5	0	130	185	147
123	D	L	S	5	3	140	188	151	183	M	L	W	5	1	127	187	152
124	M	L	S	5	5	134	187	152	184	M	L	W	5	9	133	179	146
125	D	L	S	5	1	136	196	153	**185**	M	L	S	5	0	129	185	146
126	D	D	C	5	1	136	188	142	186	M	L	C	5	1	129	181	145
127	M	M	S	5	1	137	193	149	187	M	L	S	5	1	122	188	141
128	D	D	S	5	2	134	182	140	188	M	L	W	5	4	138	198	153
129	M	L	S	5	1	127	187	140	189	D	L	S	5	3	135	186	145
130	M	D	S	5	1	121	176	140	**190**	D	D	S	5	3	139	192	142
131	D	D	S	5	3	129	195	147	191	M	D	S	5	1	135	193	150
132	D	L	S	5	7	134	198	145	192	M	M	S	5	1	126	185	148
133	M	L	W	5	3	128	181	141	193	D	L	S	5	1	137	196	154
134	M	L	W	5	2	126	184	144	194	M	L	S	5	1	136	194	148
135	D	D	S	4	8	118	177	135	**195**	M	L	S	5	3	131	191	153
136	M	D	S	4	8	125	176	138	196	M	L	S	5	1	131	191	144
137	D	D	S	4	11	135	190	146	197	D	M	S	5	3	137	191	144
138	M	M	S	5	3	132	191	149	198	D	M	S	5	3	133	188	148
139	M	L	S	5	0	128	187	143	199	M	D	S	4	9	131	197	145
140	D	L	S	4	11	134	188	148	**200**	M	L	S	5	5	136	193	147
141	M	L	S	5	0	127	184	149	201	M	D	S	5	2	130	189	144
142	D	M	S	5	1	135	192	154	202	D	D	S	5	3	134	186	141
143	D	D	S	5	3	135	182	150	203	M	D	S	4	10	137	191	146
144	D	M	S	5	2	134	189	145	204	D	D	S	5	2	136	183	142
145	D	L	S	4	11	126	192	152	**205**	M	L	S	5	2	124	189	152
146	M	D	S	5	2	133	190	140	206	M	L	S	5	4	140	200	148
147	M	M	W	4	11	130	190	152	207	M	M	S	4	11	125	183	142
148	M	L	S	5	2	133	178	147	208	M	L	S	5	6	144	199	155
149	D	L	S	4	11	124	180	140	209	D	L	S	5	0	127	189	134
150	D	L	S	5	6	133	199	145	**210**	D	D	S	5	1	124	181	136

XVI.—Lanark District Asylum.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
211	M	D	S	5	3	131	192	154	271	D	L	S	5	0	132	181	149
212	M	L	S	5	2	131	190	148	272	D	L	S	4	11	123	179	143
213	M	L	S	5	3	131	192	147	273	D	L	W	5	2	148	189	150
214	M	L	S	6	1	134	195	151	274	M	M	S	5	3	142	191	148
215	D	L	S	5	4	134	193	147	**275**	M	D	J	4	11	137	188	143
216	D	L	C	5	2	130	180	145	276	M	D	S	5	1	133	185	144
217	M	L	S	5	0	133	186	147	277	D	L	S	5	3	125	188	150
218	D	M	S	5	2	136	189	143	278	M	D	W	5	0	128	181	141
219	D	L	S	4	5	125	183	137	279	D	D	S	5	1	130	200	145
220	M	L	S	4	11	131	186	147	**280**	M	D	S	5	3	136	191	149
221	M	M	C	5	5	135	190	140	281	D	D	S	5	3	143	192	150
222	D	M	S	4	11	134	202	151	282	D	M	S	5	1	126	182	140
223	M	L	S	5	1	131	199	155	283	D	L	S	5	0	133	189	157
224	D	D	C	5	0	132	177	140	284	M	M	S	5	0	127	174	139
225	M	L	S	5	0	128	190	141	**285**	D	M	S	5	1	129	191	141
226	D	D	S	5	1	132	191	144	286	D	M	S	5	4	141	194	153
227	M	L	S	5	1	130	181	147	287	M	M	S	5	2	136	188	146
228	D	D	S	4	11	139	190	146	288	M	D	S	5	0	132	181	145
229	M	D	S	4	11	121	176	133	289	M	L	S	5	5	136	185	151
230	M	L	S	4	11	130	194	152	**290**	D	L	S	5	0	129	177	147
231	M	L	S	5	1	131	184	141	291	D	L	W	4	10	124	181	144
232	M	D	C	5	1	132	185	144	292	D	D	S	5	3	128	185	150
233	M	L	W	4	11	131	182	146	293	D	D	W	5	1	139	179	146
234	M	L	W	4	11	137	188	140	294	M	M	S	4	11	136	188	146
235	D	L	S	5	1	128	186	140	**295**	M	M	S	4	10	124	171	135
236	M	L	S	5	7	133	188	153	296	D	L	S	5	4	138	195	142
237	M	L	S	4	11	123	198	146	297	D	M	S	5	1	127	186	153
238	M	L	S	5	0	128	186	144	298	M	L	S	4	10	136	192	149
239	D	L	S	5	3	134	192	148	299	M	L	S	5	3	136	195	151
240	M	L	S	4	9	126	194	147	**300**	M	L	W	5	2	136	198	152
241	M	L	S	5	0	135	188	156	301	D	...	C	5	0	123	185	144
242	D	L	S	6	1	130	181	145	302	M	L	S	5	2	136	188	151
243	D	L	S	5	1	120	177	134	303	M	L	S	5	0	128	197	149
244	D	M	S	5	0	133	189	148	304	D	M	S	5	2	131	181	151
245	M	D	S	5	2	122	184	142	**305**	M	M	W	5	1	133	185	144
246	D	L	S	5	3	134	197	142	306	D	L	S	5	1	125	181	141
247	M	L	W	5	3	130	190	144	307	D	M	S	5	0	131	183	141
248	F	L	S	4	11	120	184	143	308	D	L	S	5	5	131	197	149
249	M	L	W	5	0	136	193	150	309	M	L	S	4	10	128	186	142
250	M	M	W	5	8	144	192	141	**310**	M	L	S	5	3	129	198	149
251	M	L	S	5	1	127	188	148	311	D	M	S	4	10	130	183	140
252	D	L	W	5	3	123	187	145	312	D	L	S	5	0	128	192	144
253	D	D	S	4	10	134	181	144	313	D	...	C	5	2	137	189	147
254	M	M	S	5	3	126	185	144	314	M	L	C	5	1	131	188	145
255	D	L	S	5	1	125	186	145	**315**	M	L	S	5	1	137	189	145
256	D	D	S	5	5	136	194	150	316	D	M	W	4	8	124	170	139
257	D	M	S	4	10	133	179	138	317	D	M	S	5	2	124	185	136
258	D	L	S	4	8	132	185	148	318	M	L	S	5	0	140	180	143
259	M	L	S	5	2	126	186	137	319	F	D	C	5	3	133	186	144
260	M	M	S	4	8	127	184	138	**320**	M	L	S	4	11	133	198	149
261	D	D	S	5	5	130	191	144	321	M	M	S	5	1	124	178	139
262	M	L	S	4	11	136	183	151	322	D	D	W	5	2	134	182	147
263	M	L	S	5	3	132	187	149	323	D	M	W	5	3	132	185	140
264	M	L	C	5	3	134	194	156	324	M	M	S	5	2	136	184	151
265	D	D	S	5	1	134	191	146	**325**	D	D	S	5	1	127	177	135
266	M	M	S	4	11	135	188	150	326	M	D	S	5	4	139	185	134
267	D	M	S	5	4	137	187	147	327	D	M	W	5	0	137	190	142
268	M	M	S	5	3	133	188	142	328	D	D	S	4	11	134	189	148
269	M	L	S	4	9	130	178	143	329	M	L	W	5	2	132	183	142
270	D	D	W	5	2	129	188	140	**330**	D	M	S	5	7	140	186	148

XVI.—Lanark District Asylum.

FEMALES.									FEMALES								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
331	M	L	S	5	2	129	183	146	346	M	L	S	5	3	133	185	140
332	D	D	S	5	3	133	192	147	347	D	M	C	5	5	137	192	153
333	D	L	S	5	0	125	183	145	348	D	L	S	4	11	132	183	144
334	M	D	S	5	2	131	189	148	349	M	M	S	4	2	131	179	146
335	D	D	W	4	10	137	186	147	**350**	D	M	S	5	3	128	182	140
336	D	M	S	5	2	138	188	148	351	M	L	S	4	11	131	186	142
337	D	M	C	5	3	135	193	147	352	M	L	S	5	2	133	185	143
338	D	M	S	4	8	130	179	138	353	D	L	S	5	0	132	188	141
339	M	M	S	5	4	133	180	144	354	D	L	S	4	10	136	188	140
340	D	M	S	5	1	130	186	146	**355**	M	L	S	5	4	121	186	137
341	D	D	W	5	1	130	186	150	356	D	L	S	5	2	123	191	143
342	M	L	W	5	0	133	184	140	357	D	L	S	5	0	127	175	145
343	M	L	S	5	3	133	187	149	358	D	L	W	5	1	129	186	143
344	D	M	S	5	2	127	180	148	359	M	L	S	5	0	127	180	137
345	M	L	S	5	2	134	187	147									

XVII.—Midlothian District Asylum.

FEMALES.									FEMALES.								
1	D	L	W	5	3	138	193	152	36	M	L	S	5	2	127	190	139
2	D	M	W	5	2	135	193	142	37	D	M	S	5	0	132	190	145
3	M	L	W	5	3	128	186	148	38	R	M	S	5	2	134	181	142
4	D	L	C	5	6	130	193	152	39	D	M	S	5	2	127	178	149
5	D	L	S	5	5	141	196	152	**40**	D	L	S	5	0	137	177	141
6	D	L	S	5	3	120	181	133	41	D	D	C	5	5	137	182	137
7	D	M	S	5	1	132	188	133	42	D	L	S	5	0	130	176	139
8	D	L	S	5	0	130	190	147	43	M	M	S	4	10	123	179	145
9	D	M	S	5	2	142	184	148	44	M	L	S	5	2	128	187	142
10	D	M	S	5	1	124	177	148	**45**	D	M	S	5	0	138	188	141
11	D	M	S	4	10	133	177	145	46	M	L	W	5	1	135	188	151
12	D	D	W	4	9	129	170	128	47	D	L	S	4	8	126	175	128
13	M	L	S	4	10	130	182	146	48	D	M	S	5	0	135	189	152
14	D	M	S	4	10	135	186	145	49	M	L	S	5	3	147	187	138
15	D	L	S	5	1	133	188	152	**50**	D	M	C	5	0	126	180	136
16	D	D	S	5	8	132	187	145	51	M	L	S	5	3	136	184	144
17	M	M	C	5	1	124	183	144	52	D	D	S	4	11	119	180	144
18	M	L	S	5	2	136	193	143	53	D	L	S	4	10	130	188	142
19	D	D	S	5	2	142	187	143	54	D	L	S	5	0	135	181	145
20	M	L	S	4	11	145	182	142	**55**	D	D	W	4	11	126	187	148
21	M	D	S	5	1	133	188	141	56	M	M	S	4	10	131	177	142
22	D	L	S	5	1	132	188	138	57	M	L	S	5	1	132	180	139
23	M	D	S	5	2	127	190	147	58	D	L	S	4	7	113	172	130
24	M	M	S	5	3	131	191	145	59	M	L	S	5	0	139	188	152
25	D	M	S	5	3	129	191	138	**60**	D	D	S	4	11	130	179	139
26	M	M	S	4	9	133	190	147	61	M	M	S	5	2	126	177	146
27	M	L	S	5	0	130	174	139	62	D	M	S	4	9	130	182	138
28	M	D	W	5	5	126	180	138	63	D	L	W	4	11	130	180	145
29	D	D	S	5	2	136	192	144	64	D	L	W	5	2	141	187	148
30	F	L	S	4	8	122	177	139	**65**	D	L	S	4	8	141	186	139
31	M	M	S	5	3	130	175	145	66	D	D	S	5	1	143	187	143
32	M	L	S	5	6	140	189	146	67	D	M	S	5	2	137	197	149
33	M	L	S	5	3	128	180	138	68	M	L	S	5	0	138	195	146
34	D	M	S	5	0	135	187	142	69	M	D	S	5	4	133	173	145
35	D	D	S	5	6	135	193	148	**70**	D	L	S	5	2	130	181	148

XVII.—Midlothian District Asylum.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
71	M	D	S	4	11	139	186	143	107	D	M	S	5	6	138	193	148
72	M	L	C	4	8	126	174	141	108	D	M	S	4	11	144	196	155
73	D	D	S	5	3	138	186	146	109	M	M	S	5	1	136	186	148
74	M	L	S	4	7	132	184	147	**110**	F	L	W	5	6	138	190	149
75	M	L	S	5	2	134	190	151	111	M	L	W	5	5	136	199	150
76	M	L	C	5	1	132	198	148	112	D	M	S	5	2	132	183	151
77	D	D	W	4	9	132	175	139	113	D	D	C	5	1	136	186	146
78	D	L	S	4	10	127	187	145	114	R	L	S	4	11	126	186	134
79	D	M	S	4	11	140	189	148	**115**	M	L	S	5	1	136	190	146
80	M	M	S	5	1	130	179	144	116	M	L	S	4	10	123	173	130
81	D	L	S	4	10	126	184	147	117	M	L	S	5	0	130	182	141
82	D	D	S	5	1	138	190	153	118	D	L	C	4	9	130	184	150
83	D	M	S	5	4	139	187	137	119	D	D	C	5	1	130	184	139
84	D	L	S	5	1	142	198	161	**120**	D	M	S	5	3	144	191	148
85	M	M	S	5	0	130	179	142	121	M	L	C	5	0	126	188	143
86	D	M	W	5	1	133	187	148	122	M	M	S	5	4	139	193	139
87	M	L	S	5	1	145	199	146	123	D	D	S	5	5	131	182	139
88	D	L	S	5	2	134	187	148	124	D	L	W	5	1	144	195	151
89	D	L	S	5	3	132	193	147	**125**	D	M	C	5	4	137	193	143
90	D	L	S	5	2	130	181	150	126	D	L	S	5	4	140	194	139
91	M	D	W	5	0	131	187	141	127	M	D	S	5	0	140	183	144
92	D	M	C	4	11	133	174	148	128	D	L	W	5	5	136	186	144
93	D	D	W	5	4	136	191	145	129	D	M	S	5	1	134	184	146
94	M	L	S	5	3	133	199	146	**130**	D	D	S	5	4	126	182	141
95	M	L	S	5	1	139	182	146	131	R	D	S	5	2	146	192	150
96	D	M	S	5	1	147	196	146	132	M	L	C	5	1	134	190	140
97	M	M	S	5	3	132	188	147	133	M	M	C	5	3	137	193	148
98	D	D	S	5	1	141	183	145	134	D	L	S	5	6	139	189	153
99	M	L	S	5	2	143	187	143	**135**	M	M	S	5	4	126	187	147
100	D	D	S	5	1	133	184	143	136	M	M	S	5	6	134	187	143
101	D	L	S	5	2	134	182	137	137	M	M	S	4	11	135	183	147
102	D	D	S	5	0	140	189	145	138	D	M	W	5	1	138	183	143
103	D	D	S	5	2	138	177	143	139	D	D	S	5	5	136	188	146
104	M	L	S	5	0	126	176	137	**140**	D	D	C	5	2	132	184	139
105	D	M	W	4	11	138	187	147	141	M	M	S	5	0	131	192	141
106	M	L	S	5	2	138	186	142	142	D	D	S	5	0	129	181	141

XVIII.—Perth District Asylum.

FEMALES.									FEMALES.								
1	M	M	S	5	4	135	189	145	16	D	D	S	4	10	132	182	142
2	M	D	S	5	2	140	191	150	17	D	D	C	4	10	131	185	143
3	M	D	S	5	1	128	180	146	18	D	D	S	5	1	134	182	143
4	D	D	S	5	0	134	181	142	19	M	M	S	5	1	139	195	151
5	F	L	S	5	1	132	188	148	**20**	D	D	S	4	9	132	198	147
6	M	M	W	5	1	134	185	143	21	M	D	C	5	5	144	189	149
7	M	M	S	5	0	131	181	141	22	D	M	S	5	1	129	182	143
8	D	L	S	5	2	124	182	138	23	M	D	S	4	10	128	180	143
9	M	D	S	4	10	134	185	149	24	F	L	S	5	0	132	195	147
10	M	L	S	5	0	128	190	156	**25**	D	D	S	4	8	124	178	141
11	M	D	S	5	1	136	181	146	26	M	L	S	5	1	136	183	143
12	R	D	S	5	5	140	192	160	27	D	M	C	5	2	126	185	142
13	M	D	S	4	10	128	180	134	28	M	M	S	5	0	130	191	147
14	D	M	S	5	1	129	182	145	29	R	L	S	5	0	135	181	145
15	D	M	S	5	3	132	182	142	**30**	D	D	S	5	1	128	176	137

XVIII.—Perth District Asylum.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
31	M	M	W	5	3	134	188	151	70	D	M	S	4	11	135	191	153
32	M	D	S	5	1	132	186	147	71	M	M	S	5	0	133	189	141
33	M	D	S	5	1	127	198	146	72	D	M	C	4	11	134	189	149
34	F	L	..	5	0	132	188	141	73	D	M	S	5	1	140	194	151
35	M	D	S	5	4	132	188	152	74	D	D	W	5	3	141	184	151
36	M	M	S	5	0	127	185	139	75	D	L	S	5	3	135	182	144
37	M	M	S	4	9	133	196	142	76	D	D	C	5	7	152	192	150
38	D	M	S	5	2	132	187	149	77	M	M	S	5	2	139	192	147
39	D	L	S	5	4	135	191	151	78	F	M	S	5	4	131	184	147
40	D	M	S	5	0	132	179	138	79	D	D	S	5	4	134	192	150
41	D	D	S	4	9	134	183	147	80	D	M	S	4	11	126	185	144
42	D	M	S	4	9	128	176	148	81	D	M	C	5	7	132	174	135
43	D	D	S	5	1	135	185	147	82	M	M	S	4	10	133	176	144
44	D	M	W	5	8	139	184	139	83	D	D	S	5	2	130	182	142
45	M	M	W	5	3	138	192	157	84	D	L	S	5	3	135	203	157
46	D	M	S	5	0	132	179	139	85	M	M	S	5	0	130	185	141
47	D	M	S	5	3	141	191	146	86	D	D	R	5	2	135	184	143
48	D	D	W	5	1	137	186	147	87	M	M	S	5	0	132	189	144
49	D	M	C	4	10	134	184	141	88	M	L	S	5	3	135	190	145
50	D	D	S	5	0	134	189	147	89	D	D	S	4	10	130	185	143
51	M	M	S	5	4	134	179	148	90	M	M	S	5	1	129	185	141
52	M	M	S	4	11	133	182	126	91	D	D	S	5	3	140	185	149
53	D	M	W	5	5	134	198	143	92	D	M	S	5	2	136	186	147
54	D	D	S	4	9	130	189	134	93	M	M	S	5	3	128	189	136
55	D	M	S	5	3	135	194	156	94	R	M	S	5	1	133	185	142
56	D	D	C	5	1	141	191	152	95	M	M	C	5	0	135	194	148
57	M	M	S	4	10	131	176	150	96	D	L	S	5	6	140	188	146
58	D	D	S	5	1	134	196	147	97	D	D	S	5	1	133	179	149
59	M	L	S	4	9	126	182	138	98	M	M	S	5	0	139	190	141
60	M	M	S	4	9	132	180	145	99	M	L	S	4	11	137	187	144
61	M	D	S	4	10	129	176	149	100	D	M	S	5	5	138	195	159
62	D	L	S	5	6	136	185	144	101	M	M	C	5	1	129	188	146
63	M	M	S	5	3	134	187	156	102	D	D	S	5	1	131	194	154
64	F	M	C	5	1	136	195	147	103	M	L	S	5	2	130	190	149
65	D	D	S	4	10	133	188	145	104	D	D	S	5	3	129	179	146
66	M	D	S	5	1	128	184	138	105	D	D	C	4	6	126	184	144
67	M	L	S	5	3	139	180	148	106	D	M	S	4	11	140	192	150
68	M	L	S	5	2	140	195	150	107	D	M	S	5	2	128	188	148
69	M	M	S	5	2	140	198	147									

XIX.—Roxburgh District Asylum.

FEMALES.									FEMALES.								
1	D	D	S	5	3	140	191	144	11	M	L	S	5	2	129	183	148
2	D	D	S	4	10	124	180	144	12	D	M	S	5	1	123	190	142
3	D	L	S	4	10	138	193	148	13	R	L	W	5	4	133	185	144
4	M	D	W	5	3	124	184	148	14	D	D	S	4	11	126	170	137
5	D	L	S	5	0	141	180	146	15	M	D	S	5	1	129	182	146
6	M	M	C	5	3	134	184	138	16	M	M	S	5	3	132	194	142
7	M	L	W	5	1	138	188	148	17	D	L	S	5	0	136	189	148
8	M	L	S	5	2	133	186	144	18	M	L	C	5	4	126	180	139
9	M	L	C	5	5	139	175	147	19	M	L	S	5	1	135	183	149
10	M	M	S	5	0	131	185	149	20	D	L	S	4	9	128	180	142

XIX.—Roxburgh District Asylum.

FEMALES.									FEMALES.								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
21	D	D	S	5	3	129	179	142	79	D	L	S	5	0	138	185	149
22	M	M	S	5	5	139	188	151	80	D	M	S	5	7	140	177	148
23	M	L	S	4	11	127	183	144	81	D	D	S	5	3	146	187	148
24	D	D	S	5	3	133	189	142	82	D	M	S	5	0	134	192	141
25	D	D	S	5	8	142	197	148	83	M	M	S	5	2	133	187	152
26	D	L	S	5	0	126	190	144	84	M	L	S	5	4	145	186	150
27	M	D	S	5	2	138	180	139	85	M	L	S	5	3	149	181	143
28	D	M	S	5	3	136	188	149	86	M	L	S	5	5	136	188	149
29	M	L	S	5	2	129	186	142	87	D	L	S	4	8	131	183	146
30	D	D	S	5	3	139	195	147	88	F	M	W	5	2	135	189	144
31	M	M	S	5	1	133	183	142	89	M	L	S	5	0	135	182	144
32	M	L	S	4	10	121	192	143	90	D	L	C	5	0	137	182	143
33	D	D	S	5	4	134	181	147	91	D	D	S	5	0	135	187	145
34	D	D	S	5	0	133	193	149	92	D	D	S	5	1	136	179	142
35	D	D	S	5	2	136	183	146	93	D	D	S	5	7	141	187	146
36	M	L	S	5	2	133	187	147	94	D	M	S	5	4	135	186	148
37	M	L	S	5	0	139	190	148	95	D	L	S	5	0	131	185	136
38	D	L	S	4	8	134	184	146	96	M	L	S	5	0	138	189	138
39	M	L	S	5	1	132	186	148	97	D	L	S	5	2	148	198	151
40	M	L	W	5	4	142	200	153	98	D	L	S	5	2	136	181	142
41	M	L	C	4	11	123	183	139	99	M	L	S	5	2	125	189	144
42	M	M	S	5	3	132	192	150	100	D	D	S	5	4	134	188	142
43	D	M	S	5	1	126	181	146	101	M	L	S	5	4	130	182	137
44	D	M	S	5	3	137	187	148	102	M	L	C	5	2	142	182	146
45	D	M	S	5	5	151	192	149	103	M	L	S	5	4	136	189	151
46	M	L	W	4	9	129	196	153	104	D	L	S	5	0	138	179	142
47	D	D	S	5	2	135	178	140	105	M	L	S	5	7	130	188	142
48	M	L	S	4	9	137	190	149	106	D	L	S	5	3	139	191	142
49	D	M	S	5	1	132	188	144	107	M	L	S	5	2	129	182	141
50	D	D	W	4	11	143	188	139	108	F	L	S	5	4	143	189	144
51	D	D	S	5	0	136	187	143	109	M	L	S	5	5	136	186	140
52	D	D	S	5	2	130	179	143	110	M	L	C	5	3	132	182	148
53	D	M	S	5	0	129	183	147	111	M	L	S	5	0	126	185	141
54	M	L	W	5	1	133	182	147	112	M	L	C	4	8	124	165	128
55	R	D	S	4	8	139	179	142	113	M	L	S	5	4	136	195	155
56	D	L	S	4	9	146	195	152	114	M	D	S	5	3	144	186	149
57	M	D	S	4	11	135	182	143	115	M	L	W	5	0	137	192	148
58	M	M	S	5	0	119	184	137	116	D	D	S	5	3	135	183	151
59	D	L	W	5	1	126	193	150	117	D	D	S	5	4	136	191	143
60	M	M	W	4	11	135	184	143	118	M	D	S	5	4	134	189	149
61	D	D	S	4	10	138	180	136	119	D	M	S	5	2	128	192	142
62	D	D	W	4	11	133	180	134	120	D	L	W	5	2	135	182	144
63	D	L	S	5	1	130	179	143	121	M	L	S	5	1	121	173	133
64	M	M	S	5	4	134	192	139	122	D	D	C	5	2	124	185	151
65	M	L	S	5	6	134	178	140	123	M	L	S	5	0	132	178	138
66	M	M	S	5	1	140	191	147	124	M	M	S	5	1	140	191	142
67	M	L	S	5	1	132	194	160	125	M	L	S	5	2	139	194	149
68	M	L	S	5	4	130	193	143	126	M	L	S	5	3	140	189	149
69	M	M	S	5	3	130	181	152	127	D	D	S	5	6	140	191	152
70	M	L	C	5	4	133	190	144	128	M	M	S	5	5	133	187	144
71	D	D	S	5	0	138	185	146	129	D	D	C	4	9	119	168	131
72	D	M	S	4	10	125	173	131	130	M	L	S	5	2	126	193	148
73	D	M	S	4	11	128	190	140	131	M	L	C	4	11	127	183	142
74	M	L	S	5	2	131	188	147	132	M	M	S	5	5	140	192	148
75	M	L	S	5	5	134	190	140	133	M	L	S	4	11	133	188	144
76	M	L	S	5	1	130	187	148	134	M	L	S	5	3	131	185	149
77	M	M	C	5	0	136	184	150	135	M	M	S	5	2	139	185	150
78	D	D	S	5	5	138	195	148	136	D	M	S	5	4	126	182	143

XX.—Stirling District Asylum.

FEMALES.								FEMALES.							
No.	Colour Character.		Shape of Nose.	Stature.	Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.	Cranial Character.		
	Hair.	Eyes.		ft. in.	H. mm.	L. mm.	B. mm.		Hair.	Eyes		ft. in.	H. mm.	L. mm.	B. mm.
1	M	M	S	5 2	132	176	146	61	M	D	S	4 9	132	183	144
2	D	M	S	4 11	142	186	147	62	D	M	S	5 2	134	184	146
3	D	D	W	5 2	145	194	157	63	D	D	S	4 11	134	176	138
4	M	M	S	5 2	134	176	143	64	D	D	W	5 1	132	187	154
5	M	L	S	5 1	135	191	146	**65**	F	M	S	4 11	134	179	141
6	F	L	S	4 9	139	181	143	66	R	M	W	5 3	133	193	146
7	D	D	S	5 8	132	189	145	67	D	D	S	5 3	136	182	141
8	M	L	S	5 1	137	186	150	68	D	D	S	5 2	136	187	151
9	M	L	S	5 0	142	182	142	69	M	M	S	5 2	136	191	154
10	M	L	C	5 4	145	189	151	**70**	D	D	S	5 0	134	191	143
11	M	M	S	5 2	131	196	151	71	D	D	S	4 7	129	179	138
12	M	M	S	5 0	137	194	145	72	M	M	C	5 4	137	186	149
13	M	M	C	5 3	140	193	147	73	D	D	S	5 4	134	191	144
14	M	M	S	5 2	144	193	154	74	M	M	S	5 0	130	176	129
15	M	D	S	5 3	143	191	143	**75**	D	M	S	4 9	128	187	140
16	M	M	S	5 1	136	191	139	76	M	M	S	4 11	131	182	145
17	D	L	S	5 3	136	182	136	77	M	L	W	5 1	139	178	137
18	D	D	S	5 0	128	177	137	78	D	D	S	5 0	130	190	145
19	D	D	S	5 4	131	184	146	79	M	L	S	5 4	138	196	156
20	D	M	C	5 3	145	194	150	**80**	R	L	C	4 10	133	179	143
21	M	L	S	5 2	134	192	150	81	D	L	C	5 3	128	184	143
22	M	M	S	4 8	134	187	143	82	D	L	C	5 1	136	192	144
23	D	M	S	5 1	135	182	145	83	M	M	W	5 1	140	186	153
24	M	L	W	5 1	144	191	154	84	D	D	S	5 6	129	180	145
25	M	M	C	5 2	138	184	147	**85**	D	D	S	5 8	128	190	151
26	M	M	S	5 2	133	186	146	86	M	L	S	4 11	138	180	149
27	M	D	S	4 6	118	166	129	87	D	D	S	5 1	135	176	138
28	M	M	S	5 5	147	191	148	88	D	D	W	4 10	139	190	144
29	D	M	S	5 1	130	183	143	89	M	M	S	5 2	123	187	147
30	M	M	S	4 11	134	195	151	**90**	M	M	W	4 11	132	178	144
31	D	D	S	4 11	138	191	147	91	D	D	S	4 9	136	189	145
32	D	D	S	4 10	130	189	144	92	D	M	C	5 0	136	187	151
33	M	D	S	5 1	132	178	140	93	D	D	W	4 10	138	201	150
34	M	D	C	5 1	134	187	137	94	D	D	S	4 11	112	174	132
35	D	D	S	5 4	130	183	140	**95**	F	M	R	5 1	134	190	143
36	D	D	S	5 2	135	189	149	96	F	M	S	5 2	130	187	143
37	M	M	S	5 3	128	173	144	97	D	M	S	5 1	144	192	147
38	D	M	S	5 1	134	189	144	98	D	M	S	4 7	131	178	150
39	D	D	S	5 1	124	183	144	99	D	M	W	4 11	132	182	141
40	D	D	S	4 11	125	186	147	**100**	D	D	S	5 1	131	181	140
41	D	D	S	4 8	129	174	141	101	D	M	W	5 3	138	193	145
42	F	M	S	4 11	122	183	143	102	M	M	S	5 1	137	197	146
43	M	L	S	5 0	134	193	145	103	D	D	C	4 10	136	184	147
44	M	M	S	4 9	132	191	141	104	D	M	S	5 0	132	187	150
45	F	L	C	5 0	129	191	148	**105**	D	D	W	5 2	126	189	137
46	D	M	S	5 2	134	198	150	106	D	M	W	5 4	142	196	148
47	F	L	S	5 2	134	187	145	107	D	D	S	5 2	143	190	147
48	D	D	S	5 4	135	194	149	108	D	D	S	5 0	134	186	150
49	M	M	S	5 6	139	179	150	109	D	L	W	4 11	128	187	136
50	D	M	W	5 1	143	197	148	**110**	D	M	C	4 8	125	183	143
51	D	D	W	5 2	146	201	150	111	D	L	S	5 5	132	187	147
52	M	D	S	5 5	131	189	143	112	R	M	W	5 3	134	199	149
53	D	L	C	5 3	140	196	151	113	D	D	S	4 11	135	181	145
54	M	M	S	4 11	133	188	150	114	D	D	S	5 3	133	187	146
55	D	D	S	4 10	127	178	143	**115**	R	L	S	5 0	132	184	143
56	F	D	S	5 2	131	191	154	116	D	D	S	4 10	134	182	143
57	M	M	W	5 0	131	187	142	117	R	M	C	4 11	137	190	141
58	M	L	S	4 10	128	179	146	118	F	M	S	5 4	145	195	147
59	D	M	S	4 9	124	183	140	119	M	M	S	5 5	136	188	143
60	D	D	C	4 7	129	175	144	**120**	M	M	S	4 10	132	190	148

XX.—Stirling District Asylum.

FEMALES.

No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
121	D	D	S	5	2	136	188	140
122	M	M	C	5	1	135	189	150
123	M	M	S	5	2	123	180	141
124	D	M	S	5	3	136	187	144
125	M	D	S	5	1	132	187	144
126	D	D	S	4	9	134	195	158
127	D	M	S	5	0	137	192	145
128	M	M	S	5	5	135	183	142
129	D	L	S	5	0	133	191	143
130	D	D	S	5	0	139	192	147
131	M	M	S	5	2	135	195	145
132	D	D	S	5	2	134	182	144
133	M	D	S	4	9	131	190	149
134	M	M	S	5	0	130	187	138
135	D	D	S	5	4	126	179	143
136	D	D	S	5	0	136	182	147
137	D	M	S	5	1	128	187	141
138	M	M	S	5	2	124	187	143
139	D	D	S	5	2	136	192	149
140	M	M	S	4	7	125	183	143
141	D	M	S	4	10	136	189	146
142	M	D	S	4	10	136	192	144
143	D	D	C	4	9	141	184	154
144	D	D	S	4	7	136	180	142
145	M	D	C	5	2	132	196	149
146	D	M	S	4	6	134	183	145
147	M	D	S	5	2	128	179	137
148	M	D	W	4	11	130	186	151
149	D	M	C	5	2	134	186	142
150	M	M	S	5	3	134	186	141
151	M	D	S	5	2	122	177	143
152	D	D	S	4	11	126	194	148
153	M	M	W	5	2	134	182	140
154	M	L	S	4	6	129	188	145
155	M	L	S	5	2	129	177	138
156	D	D	S	5	3	138	195	147
157	M	L	W	4	10	132	189	154
158	D	D	C	5	2	139	184	149
159	D	M	S	5	5	123	175	141
160	M	L	S	4	8	123	183	144
161	M	M	W	5	3	137	192	150
162	M	M	S	4	9	140	189	148
163	D	L	S	5	1	135	193	148
164	D	D	W	5	3	137	192	156
165	M	D	S	5	1	141	194	150
166	M	L	S	4	11	129	186	145
167	D	L	C	5	0	131	193	141
168	D	L	S	4	10	142	180	140
169	D	D	W	5	2	143	180	150
170	D	D	W	4	11	141	196	149
171	D	L	S	4	11	135	188	151
172	M	L	S	4	9	126	173	133
173	M	M	S	4	11	127	183	138
174	D	L	S	5	2	128	191	145
175	F	L	W	4	0	123	158	132
176	M	L	S	5	3	136	188	141
177	D	M	S	5	3	133	189	147
178	D	M	S	4	11	140	193	147
179	M	M	W	5	1	135	188	145
180	D	M	S	5	2	136	187	140

FEMALES.

No.	Colour Character.		Shape of Nose.	Stature		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
181	F	L	S	4	5	123	187	142
182	D	M	C	5	2	131	189	145
183	D	D	S	5	2	133	179	149
184	D	M	S	5	3	142	188	144
185	D	L	S	4	11	125	185	140
186	D	D	S	5	3	135	177	146
187	D	L	S	5	3	131	193	147
188	D	D	S	5	3	141	180	140
189	D	M	S	5	0	145	183	142
190	F	L	C	5	11	132	191	139
191	D	M	R	5	1	124	180	142
192	M	L	S	4	10	125	193	142
193	D	D	S	4	9	133	177	140
194	D	L	S	5	0	134	199	149
195	D	D	S	5	1	131	192	141
196	D	D	S	5	2	139	183	150
197	D	...	C	4	9	125	187	140
198	D	L	S	5	4	145	190	143
199	D	L	S	4	9	142	191	148
200	D	D	S	5	0	135	187	142
201	D	D	C	5	2	134	192	143
202	D	D	S	4	11	137	190	147
203	R	M	S	5	7	134	178	145
204	M	M	W	4	9	126	185	140
205	D	D	S	5	0	143	192	145
206	D	M	S	5	3	138	192	148
207	D	M	S	5	6	136	190	146
208	M	M	C	4	1	125	181	125
209	M	D	S	4	11	137	186	144
210	M	D	S	5	0	115	181	136
211	D	M	C	4	11	122	179	142
212	R	D	W	5	2	132	183	140
213	M	L	S	4	11	132	175	139
214	D	M	S	5	3	123	192	140
215	M	D	S	5	3	139	186	145
216	M	M	C	5	1	133	181	148
217	D	L	W	5	2	140	186	145
218	D	M	C	5	2	132	188	143
219	M	M	W	4	11	140	183	145
220	D	M	W	5	2	146	197	157
221	R	M	W	5	2	131	190	152
222	D	D	W	5	2	136	191	147
223	D	L	W	5	2	141	191	147
224	D	L	S	5	3	130	190	141
225	D	...	W	4	8	139	194	150
226	D	L	S	5	1	123	184	147
227	D	...	W	5	6	120	190	141
228	M	L	S	4	11	131	188	140
229	D	L	S	5	1	124	190	135
230	F	L	S	5	0	137	190	151
231	M	L	S	5	0	132	189	144
232	D	...	C	4	7	127	173	131
233	M	M	S	5	1	126	187	142
234	M	M	S	5	2	138	187	148
235	F	M	C	4	6	127	186	147
236	D	D	S	5	0	129	185	143
237	D	D	S	5	0	127	180	143
238	D	D	S	5	2	136	185	136
239	D	D	S	5	0	133	190	150
240	D	L	S	4	10	127	185	144

XX.—Stirling District Asylum.

FEMALES.

No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
241	R	D	S	4	11	131	186	145
242	M	L	S	5	0	142	191	149
243	M	D	S	5	3	134	186	151
244	D	D	S	5	0	132	178	132
245	D	M	S	5	3	131	189	147
246	F	L	S	5	5	135	187	147
247	M	M	W	5	1	139	193	145
248	M	L	C	4	8	137	177	140
249	D	D	S	5	1	139	190	149
25	M	D	W	5	1	138	179	139

XXI.—Greenock Parochial Asylum.

FEMALES.

No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
1	F	L	S	5	0	132	186	150
2	M	M	S	5	0	124	184	144
3	D	D	C	5	4	132	187	145
4	M	D	S	5	4	136	194	153
5	M	L	S	4	8	129	187	141
6	D	M	S	4	9	127	185	150
7	M	D	S	4	9	122	185	145
8	D	L	C	4	9	125	185	148
9	M	M	W	4	1	106	154	123
10	M	M	C	5	5	130	189	142
11	D	M	S	5	1	127	187	150
12	M	M	S	4	10	125	186	143
13	D	L	S	5	4	131	181	140
14	M	L	S	5	2	124	181	144
15	M	L	S	5	1	129	194	139
16	M	D	S	5	0	129	179	141
17	M	M	S	4	10	130	181	149
18	M	D	C	4	10	125	177	136
19	M	D	S	4	8	128	181	143
20	M	L	S	4	9	127	185	144
21	D	M	S	5	1	129	195	149
22	M	L	S	4	10	124	176	136
23	M	L	S	4	10	124	181	143
24	M	M	S	5	0	123	180	141
25	M	D	S	5	2	123	186	143
26	M	M	S	5	0	134	184	148
27	M	L	S	5	2	137	199	154
28	M	L	C	5	2	141	188	148
29	M	M	S	5	0	128	180	140
30	M	M	S	5	5	132	192	148
31	D	M	S	4	10	129	182	140
32	M	D	S	5	3	135	191	147
33	D	L	S	4	9	127	182	144
34	M	D	S	4	10	121	170	137
35	M	L	S	5	2	132	186	144
36	F	D	S	4	10	132	187	155
37	D	L	S	5	5	140	191	151
38	M	L	S	5	0	134	186	140
39	D	L	S	4	10	134	189	144
40	M	L	S	5	0	130	191	143
41	M	D	S	4	9	128	182	146
42	D	M	S	4	9	123	173	134
43	M	L	S	4	10	128	179	139
44	D	L	W	5	0	124	180	141
45	M	L	S	4	7	123	180	143
46	D	L	S	4	7	119	182	136
47	M	D	S	5	3	134	184	142
48	M	M	S	5	5	128	181	136
49	M	L	S	5	3	127	182	143
50	M	L	S	5	2	135	187	148
51	M	M	S	5	3	136	191	155
52	D	D	S	5	3	132	185	146
53	M	L	S	5	2	133	192	149
54	M	L	S	5	1	131	196	149
55	D	L	S	4	10	134	187	147
56	D	M	S	5	4	134	186	141
57	D	D	S	4	8	127	178	145
58	M	D	S	5	1	136	195	146
59	D	D	S	5	2	131	188	148
60	M	D	C	4	10	129	185	145
61	D	D	S	4	10	134	185	149
62	D	D	S	5	4	128	180	148
63	M	L	S	5	4	133	180	144
64	M	L	S	5	0	122	182	139
65	M	D	S	5	1	135	188	151
66	M	M	S	5	1	130	196	151
67	D	D	S	5	2	125	182	137
68	M	M	S	4	9	124	184	145
69	M	M	C	3	8	130	193	136
70	M	L	S	4	9	125	191	148
71	M	D	S	5	1	128	188	148
72	F	L	S	4	10	129	173	139
73	M	D	S	4	10	132	178	136
74	M	M	S	5	1	126	187	145
75	M	M	S	5	2	125	190	149
76	M	L	S	4	8	119	173	131
77	D	D	S	5	3	131	189	140
78	M	L	S	5	0	129	185	143
79	D	D	S	5	5	128	185	139
80	M	M	S	5	0	127	187	141
81	M	L	S	5	2	126	185	145
82	M	M	S	5	2	132	192	148
83	M	M	S	5	1	122	183	146
84	D	L	S	5	0	124	190	146
85	M	M	S	4	7	131	196	151
86	D	D	S	5	2	128	187	151
87	M	D	S	5	3	136	183	151
88	D	L	S	4	9	133	184	140
89	M	L	S	4	11	125	189	144
90	M	...	S	5	0	120	182	143

XXI.—Greenock Parochial Asylum.

FEMALES.									FEMALES								
No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.			No.	Colour Character.		Shape of Nose.	Stature.		Cranial Character.		
	Hair.	Eyes.		ft.	in	H. mm.	L. mm.	B. mm.		Hair.	Eyes.		ft.	in.	H. mm.	L. mm.	B. mm.
91	M	M	S	5	1	123	183	144	97	D	L	S	5	3	126	190	145
92	M	M	S	4	11	125	191	150	98	M	D	S	5	0	126	184	146
93	M	L	S	5	3	130	194	142	99	M	L	S	4	10	129	187	150
94	M	M	S	5	0	128	180	141	**100**	M	M	S	5	0	124	184	140
95	M	M	S	5	1	139	182	146	101	M	M	S	4	9	126	184	138
96	M	D	W	5	3	134	189	150									

XXII.—Paisley Parochial Asylum.

FEMALES.									FEMALES.								
1	M	M	S	5	1	138	193	146	48	M	D	S	5	5	135	198	146
2	D	M	S	4	4	133	187	146	49	M	L	S	5	2	128	179	147
3	M	L	S	5	1	134	191	147	**50**	D	L	S	5	6	138	181	153
4	M	M	S	5	3	137	182	146	51	D	M	S	5	0	134	184	149
5	M	L	S	5	1	134	179	142	52	M	L	S	5	3	131	187	143
6	M	D	S	5	0	129	182	143	53	M	M	S	4	10	122	186	149
7	M	M	C	4	9	133	190	148	54	M	L	S	4	7	132	188	153
8	D	D	S	4	11	123	187	151	**55**	M	L	S	5	1	132	187	142
9	M	L	S	5	4	134	188	151	56	M	L	S	5	2	132	191	143
10	M	L	S	5	3	138	187	147	57	M	L	S	5	2	129	190	148
11	D	M	S	5	7	144	188	139	58	M	L	S	5	2	134	190	148
12	D	L	S	5	2	138	189	153	59	M	D	S	5	4	142	184	148
13	M	L	S	5	2	140	189	144	**60**	D	D	S	5	0	124	189	148
14	M	L	S	5	0	132	184	145	61	M	D	S	5	0	135	187	152
15	M	M	S	4	11	126	184	144	62	M	D	S	5	3	131	193	143
16	M	...	S	4	8	131	181	137	63	M	M	S	5	0	127	186	148
17	F	M	S	5	2	142	191	143	64	M	L	S	5	0	134	190	145
18	M	M	S	5	4	131	179	142	**65**	M	L	C	5	4	135	192	145
19	D	L	S	5	4	129	187	141	66	M	D	S	5	4	132	187	144
20	M	D	S	4	11	127	188	145	67	F	D	C	5	2	135	200	147
21	M	D	S	4	9	123	172	138	68	M	L	S	4	11	135	187	144
22	M	L	S	5	5	132	187	149	69	D	L	S	4	11	126	179	130
23	M	D	S	4	10	127	194	140	**70**	D	M	S	5	1	123	175	147
24	M	L	S	5	0	129	192	145	71	M	M	S	5	8	132	188	148
25	M	M	C	5	3	132	195	142	72	M	D	S	5	3	130	191	140
26	D	L	S	5	3	137	182	146	73	M	M	S	5	2	142	193	150
27	D	M	S	5	1	135	194	151	74	M	D	S	4	10	138	178	145
28	M	M	C	5	2	134	192	146	**75**	M	M	S	4	11	128	182	139
29	F	M	W	5	1	131	187	151	76	M	L	S	5	2	131	182	147
30	M	L	S	4	11	131	191	144	77	M	M	W	5	2	132	172	151
31	M	M	S	5	3	131	184	144	78	M	M	S	5	0	124	181	142
32	D	L	S	5	1	128	190	145	79	M	L	S	5	3	138	193	148
33	M	L	S	4	11	131	189	138	**80**	F	L	S	4	9	131	170	140
34	F	L	S	5	2	141	187	146	81	D	M	W	5	0	136	194	150
35	R	M	S	5	3	138	197	146	82	M	L	W	5	3	138	196	149
36	D	L	S	5	0	134	197	154	83	M	L	S	5	1	136	186	147
37	M	L	W	5	3	129	194	151	84	M	M	S	5	2	141	182	152
38	M	D	S	5	0	131	187	141	**85**	M	M	S	5	4	136	180	136
39	M	L	S	5	8	140	183	145	86	F	M	C	5	4	136	200	157
40	M	D	C	5	0	132	189	142	87	D	M	S	4	11	140	177	149
41	M	L	C	5	0	138	191	153	88	D	M	S	5	0	131	184	145
42	M	L	S	5	1	137	195	146	89	D	D	S	5	2	137	187	148
43	M	L	S	5	1	141	190	152	**90**	D	M	S	5	3	137	189	145
44	M	D	S	4	11	126	183	140	91	D	M	W	5	6	141	193	146
45	D	L	S	5	3	128	187	137	92	M	L	S	5	0	140	198	154
46	M	L	S	5	4	127	183	154	93	M	D	S	5	2	130	184	143
47	M	M	S	4	11	132	190	141									

APPENDIX II.—TABLES OF CLASSIFIED DATA.

TABLE I.—TABLE OF FREQUENCIES.

MALES.						FEMALES.					
Head Height.	Frequency.	Head Breadth.	Frequency.	Head Length.	Frequency.	Head Height.	Frequency.	Head Breadth.	Frequency.	Head Length.	Frequency.
109	1	125	1	162	1	106	1	122	1	151	1
110	...	126	...	163	1	107	...	123	1	152	1
111	...	127	...	164	2	108	1	124	2	153	...
112	...	128	...	165	...	109	...	125	1	154	1
113	...	129	1	166	...	110	...	126	1	155	...
114	...	130	2	167	...	111	1	127	1	156	...
115	...	131	...	168	2	112	2	128	5	157	...
116	1	132	7	169	...	113	2	129	5	158	1
117	1	133	4	170	...	114	4	130	7	159	..
118	6	134	7	171	1	115	4	131	6	160	...
119	3	135	6	172	1	116	4	132	7	161	1
120	3	136	2	173	1	117	8	133	20	162	...
121	8	137	7	174	5	118	7	134	21	163	1
122	7	138	15	175	6	119	22	135	30	164	...
123	13	139	18	176	4	120	45	136	51	165	2
124	22	140	43	177	7	121	48	137	65	166	2
125	34	141	45	178	11	122	57	138	106	167	2
126	47	142	72	179	9	123	115	139	131	168	4
127	54	143	99	180	13	124	133	140	167	169	6
128	90	144	103	181	26	125	171	141	220	170	8
129	115	145	151	182	41	126	208	142	276	171	13
130	157	146	177	183	42	127	230	143	286	172	18
131	188	147	230	184	50	128	268	144	319	173	30
132	235	148	265	185	78	129	261	145	340	174	23
133	271	149	294	186	88	130	279	146	321	175	35
134	337	150	320	187	103	131	281	147	281	176	48
135	358	151	330	188	150	132	288	148	291	177	67
136	301	152	334	189	166	133	268	149	244	178	96
137	299	153	320	190	185	134	248	150	207	179	127
138	289	154	289	191	194	135	204	151	161	180	153
139	274	155	268	192	239	136	189	152	110	181	167
140	274	156	241	193	261	137	135	153	86	182	207
141	206	157	188	194	263	138	125	154	59	183	235
142	189	158	179	195	273	139	97	155	41	184	247
143	144	159	124	196	262	140	79	156	27	185	261
144	119	160	90	197	253	141	45	157	15	186	244
145	99	161	54	198	262	142	30	158	17	187	272
146	62	162	50	199	235	143	20	159	8	188	259
147	48	163	32	200	214	144	20	160	4	189	227
148	38	164	27	201	190	145	18	161	4	190	215
149	25	165	13	202	172	146	9	162	3	191	199
150	32	166	11	203	150	147	7	163	1	192	159
151	16	167	4	204	106	148	7	164	...	193	136
152	14	168	3	205	94	149	4	165	...	194	113
153	22	169	4	206	61	150	2	166	1	195	91
154	9	170	2	207	53	151	2	167	...	196	79
155	10	171	...	208	49	152	2	168	..	197	46
156	2	172	2	209	30	...	...	169	...	198	50
157	2	173	...	210	27	...	...	170	...	199	30
158	5	174	...	211	18	...	...	171	...	200	25
159	4	175	1	212	12	...	...	172	...	201	18
160	1	176	...	213	7	...	...	173	...	202	17
161	...	177	...	214	1	...	...	174	...	203	4
162	...	178	...	215	2	...	...	175	..	204	3
163	...	179	...	216	3	...	...	176	...	205	2
164	...	180	...	217	6	...	...	177	...	206	1
165	1	181	...	218	2	...	..	178	1	207	4
		194	1	*220*	2						
				222	1						
				228	1						
	4436		4436		4436		3951		3951		3951

TABLE II.—TABLE OF HEAD LENGTHS AND HEAD BREADTHS—4436 *Male Inmates.*

Head Length (Millimetres).

Head Breadth (Millimetres).

	162	*163*	*164*	*168*	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	*222*	*228*	Totals
125	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
129	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
130	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
131	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
132	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	1	1	–	–	–	–	–	–	–	–	1	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
133	–	–	–	1	–	1	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
134	–	–	–	–	–	–	–	–	–	1	–	–	1	1	–	–	1	1	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
135	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	–	1	1	–	–	–	1	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
136	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
137	–	–	–	–	–	–	–	–	–	–	–	1	–	1	1	–	1	–	–	–	–	1	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
138	–	–	–	–	–	–	–	–	2	–	1	1	–	–	–	–	1	–	1	1	1	–	–	3	1	1	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	15
139	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	1	–	1	–	3	2	–	1	2	1	1	1	1	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18
140	–	–	1	1	–	–	–	–	–	–	–	–	–	2	1	3	1	2	4	1	–	5	3	2	3	3	2	3	–	2	1	1	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	43
141	–	–	–	–	–	–	–	–	1	1	–	1	2	–	1	–	2	–	2	1	4	3	2	4	2	4	1	3	2	4	–	3	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	45
142	–	–	–	–	–	–	1	–	–	1	1	–	–	1	–	2	2	2	3	4	5	10	5	4	3	4	8	5	4	2	1	1	–	1	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	72
143	–	–	–	–	–	–	–	–	–	–	–	–	2	–	1	1	3	4	4	4	5	5	10	5	4	5	5	8	5	5	3	3	3	5	5	3	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	99
144	–	–	–	–	–	–	–	1	–	–	–	1	–	1	1	3	2	–	3	4	6	3	9	8	11	8	6	7	5	4	7	–	5	3	1	1	1	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	103
145	1	–	–	–	–	–	–	–	–	1	–	–	1	1	1	2	5	2	2	12	4	3	5	9	10	17	5	9	9	14	9	5	8	3	5	2	2	–	–	3	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	151
146	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	2	2	1	3	7	7	7	7	12	12	12	17	16	12	10	8	10	8	6	4	4	1	–	3	–	–	2	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	177
147	–	–	–	–	–	–	–	–	–	1	–	–	2	–	2	3	4	7	1	4	9	6	20	8	21	18	11	16	13	11	13	10	12	11	4	7	6	3	4	–	1	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	230
148	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	3	2	2	7	4	10	5	18	18	16	12	21	13	27	13	12	16	11	17	9	6	7	5	2	2	2	3	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	265
149	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1	4	4	6	5	7	8	12	14	13	23	17	20	25	22	23	19	13	16	12	11	9	2	4	1	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	294
150	–	–	–	–	–	–	–	–	1	–	–	2	–	–	1	–	2	1	6	5	4	11	9	20	21	17	23	21	18	27	21	16	16	15	20	17	8	7	3	4	2	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	320
151	–	–	–	–	–	–	–	–	–	–	1	–	1	1	–	1	2	4	1	5	5	3	8	12	11	13	22	25	24	21	34	23	21	15	19	7	12	9	9	5	6	3	3	–	2	1	1	–	–	–	–	–	–	–	–	–	–	330
152	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	3	1	1	3	7	7	4	9	10	19	21	24	23	17	28	25	20	17	20	13	11	13	12	9	4	3	4	3	–	–	1	–	–	–	–	–	–	–	–	–	–	334
153	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	2	1	1	6	3	9	9	11	13	13	18	33	29	18	22	22	15	17	12	22	9	8	5	4	3	5	2	2	1	3	–	–	–	–	–	–	–	–	–	–	320
154	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	2	4	3	3	6	5	11	7	6	13	18	18	9	21	22	26	22	15	12	13	16	8	9	5	4	2	2	1	1	–	–	–	–	1	–	1	–	–	–	–	289
155	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	4	2	4	5	3	13	6	11	18	7	17	12	14	18	23	19	15	14	18	10	6	6	5	8	4	2	–	1	–	–	1	–	–	–	–	–	–	–	268
156	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	2	1	3	2	5	5	7	14	12	15	17	18	12	18	12	20	15	8	19	7	6	4	4	6	2	3	1	1	–	–	–	–	–	–	–	–	–	–	241
157	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	4	3	2	–	5	5	9	8	11	9	14	18	17	12	13	15	8	7	7	5	4	–	4	2	–	1	1	–	–	–	1	1	–	–	–	–	188
158	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1	–	1	–	2	4	1	4	3	5	5	7	18	11	11	11	11	4	7	14	8	10	11	4	8	1	3	3	4	1	3	–	–	–	1	–	–	–	–	–	179
159	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	2	1	3	1	6	4	4	5	4	6	10	7	12	13	7	6	2	4	5	5	8	3	1	1	–	–	–	–	–	1	–	–	1	–	–	124
160	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	4	2	2	1	–	4	1	6	4	4	6	6	5	9	5	7	5	9	1	–	1	2	1	2	–	–	–	–	1	1	–	–	–	–	–	90
161	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	2	1	2	–	3	–	–	3	2	1	5	3	3	3	6	5	3	–	4	2	1	–	–	1	1	–	–	–	–	–	1	–	–	–	–	–	54
162	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	2	–	–	–	2	2	1	2	2	1	4	1	3	4	2	2	7	2	3	1	2	2	–	2	–	1	–	–	–	–	–	–	1	–	–	50
163	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	2	2	1	4	3	1	5	3	1	–	–	1	2	3	2	–	–	–	–	–	–	–	–	–	–	32
164	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	–	1	1	1	–	4	–	3	1	4	1	–	–	1	–	–	3	1	–	1	–	1	1	1	–	–	–	–	–	27
165	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	2	1	–	–	–	3	1	–	–	–	1	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	13
166	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	–	–	–	1	–	2	–	1	–	–	–	–	2	–	2	–	1	–	–	–	–	–	–	–	–	–	–	–	–	11
167	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	1	–	4
168	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	3
169	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	1	–	–	–	–	–	–	–	–	–	–	4
170	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
171	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
172	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	2
175	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
194	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
Totals	1	1	2	2	–	1	1	1	5	6	4	7	11	9	13	26	41	42	50	78	88	103	150	166	185	194	239	261	263	273	262	253	262	235	214	190	172	150	106	94	61	53	49	30	27	18	12	7	1	2	3	6	2	–	2	1	1	4436

TABLE III.—TABLE OF HEAD LENGTHS AND HEAD HEIGHTS—4436 *Male Inmates.*

Head Length (Millimetres).

Head Height (Millimetres).	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	*228*	Totals
115	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
116	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
117	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
118	1	–	–	–	–	–	–	1	1	–	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
119	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
120	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
121	1	–	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	–	–	–	1	–	1	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8
122	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	2	–	–	–	1	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
123	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1	–	1	4	1	1	1	1	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13
124	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	2	3	1	1	–	1	1	3	3	–	3	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22
125	–	–	–	–	–	–	1	1	1	–	1	3	3	–	2	1	1	1	4	2	2	–	–	–	2	4	1	–	1	–	–	2	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	34
126	–	–	–	1	1	1	–	–	1	–	–	4	3	1	2	2	–	6	1	4	6	5	4	2	1	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	47
127	–	–	–	–	1	1	–	–	–	1	–	1	2	2	3	3	4	3	4	2	4	4	1	6	3	1	1	–	–	4	1	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	54
128	–	–	–	–	–	–	–	1	2	1	1	2	3	2	2	4	3	–	4	7	5	11	5	7	6	5	3	5	4	5	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	90
129	–	–	–	–	–	–	–	1	2	1	1	1	2	3	4	4	11	5	8	8	5	3	6	6	3	6	5	9	5	5	6	–	1	–	–	–	–	2	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	115
130	1	–	–	–	2	–	–	–	–	–	1	4	–	4	3	7	6	3	14	9	10	12	8	12	10	8	6	6	6	6	9	1	2	2	4	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	157
131	1	–	–	–	1	1	1	–	–	–	1	1	4	4	5	4	4	3	10	10	12	10	16	11	10	13	17	6	5	6	10	9	3	3	1	4	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	188
132	–	–	–	–	–	1	–	–	–	2	–	–	1	5	6	1	10	10	6	17	16	11	16	15	13	14	23	8	14	7	7	13	3	3	4	1	1	4	2	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	235
133	–	–	–	–	–	1	–	–	1	–	1	2	4	6	4	7	7	11	15	16	13	10	16	20	19	15	9	19	11	12	14	10	11	5	3	6	–	–	–	–	–	2	1	–	–	–	–	–	–	–	–	–	–	–	271
134	1	–	–	–	–	–	–	–	1	1	2	3	4	6	5	6	14	7	18	22	6	17	21	29	19	22	23	17	9	15	14	14	12	7	4	4	5	1	3	2	2	–	1	–	–	–	–	–	–	–	–	–	–	–	337
135	–	–	–	–	–	–	–	–	–	1	–	2	1	3	3	3	6	10	8	9	23	15	15	32	36	23	17	17	26	18	20	17	12	10	5	8	6	5	3	2	1	1	–	–	–	–	–	–	–	–	–	–	–	–	358
136	–	–	–	–	–	–	–	–	–	–	1	–	2	2	4	6	–	4	12	9	5	16	21	24	21	27	24	16	14	11	13	12	9	13	10	6	2	4	4	3	2	1	3	–	–	–	–	–	–	–	–	–	–	–	301
137	–	–	–	–	–	–	–	–	–	–	1	–	2	1	1	5	4	8	8	12	15	11	16	20	32	16	19	16	19	18	13	9	8	13	7	10	4	4	1	2	1	–	–	1	1	–	–	–	–	–	1	–	–	–	299
138	–	–	–	–	–	–	–	–	–	–	1	–	1	–	3	4	3	9	9	10	6	13	11	15	14	24	17	25	35	14	12	12	8	14	3	6	6	4	–	1	1	4	1	1	–	–	1	1	–	–	–	–	–	–	289
139	–	–	–	–	–	–	2	–	–	–	–	–	3	–	1	6	2	3	7	6	13	9	16	9	13	20	18	17	15	19	17	13	13	16	7	10	4	7	2	3	1	1	–	–	–	–	1	–	–	–	–	–	–	–	274
140	–	–	1	–	–	–	–	–	–	–	–	1	2	1	1	2	3	4	5	6	10	12	19	7	8	16	20	21	17	23	20	10	19	14	5	8	6	2	3	3	2	1	1	–	–	1	–	–	–	–	–	–	–	–	274
141	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	3	1	2	4	2	8	5	15	9	8	9	14	17	20	9	15	8	10	10	13	4	6	3	3	5	1	–	1	–	–	–	–	–	–	–	–	–	–	–	206
142	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	1	2	4	1	8	5	6	12	8	9	15	12	9	16	10	10	11	12	6	7	4	4	5	6	3	1	–	–	–	–	–	–	–	–	–	–	–	–	–	189
143	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	3	3	4	4	5	12	6	6	8	12	14	7	11	8	8	5	5	4	4	4	–	4	2	1	1	–	–	–	1	–	–	–	–	–	–	144
144	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	2	–	2	–	–	2	3	2	6	5	5	7	7	8	13	8	6	11	4	6	5	1	2	6	1	3	–	1	2	–	–	–	–	–	–	–	–	–	–	119
145	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	4	3	–	5	1	2	4	5	3	4	9	6	7	2	10	5	5	8	4	1	–	4	–	3	–	–	–	–	–	–	1	–	–	1	–	–	–	99
146	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	–	3	–	–	2	1	7	3	2	4	5	5	8	5	3	5	1	1	–	1	–	2	1	1	–	–	–	–	–	–	–	–	–	–	–	62
147	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	5	2	1	1	3	3	3	3	3	4	4	1	2	3	–	4	2	1	–	1	–	–	–	–	–	–	1	–	–	–	–	–	–	48
148	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	–	2	–	2	2	3	–	3	1	1	2	1	3	1	2	5	5	–	1	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	38
149	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	1	–	1	2	–	2	4	2	–	2	–	1	2	1	1	1	1	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	25
150	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	–	1	3	–	2	2	4	2	–	–	4	3	1	–	3	2	1	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	32
151	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2	–	1	2	–	–	1	2	1	1	1	–	1	1	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	16
152	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	2	1	2	–	2	1	–	–	–	1	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–	–	–	14
153	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	1	–	–	1	2	2	2	3	–	1	1	–	1	2	2	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	22
154	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	1	–	–	–	–	1	–	1	–	1	–	1	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	9
155	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	1	2	–	–	1	–	–	–	–	1	–	–	–	1	–	–	–	–	–	–	1	1	–	–	–	–	–	–	10
156	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
157	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	2
158	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	2	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	–	5
159	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
160	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1
161	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
162	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
163	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
165	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
Totals	6	1	1	1	5	6	4	7	11	9	13	26	41	42	50	78	88	103	150	166	185	194	239	261	263	273	262	253	262	235	214	190	172	150	106	94	61	53	49	30	27	18	12	7	1	2	3	6	2	–	2	–	1	1	4436

TABLE IV.—TABLE OF HEAD HEIGHTS AND HEAD BREADTHS—4436 *Male Inmates.*

Head Breadth (Millimetres).

Head Height (Millimetres).	*123*	*124*	*125*	*129*	*130*	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	*172*	*175*	*194*	*195*	*196*	Totals
116	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
117	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
118	–	–	1	–	–	1	–	–	1	–	1	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
119	–	–	–	–	1	–	1	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
120	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
121	–	–	–	–	–	–	–	1	–	–	–	–	–	2	–	1	–	1	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8
122	–	–	–	1	–	–	–	2	–	–	–	–	–	–	1	1	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
123	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1	2	–	–	2	1	2	1	1	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13
124	–	–	–	–	–	–	–	–	–	–	–	1	1	1	1	–	2	–	3	3	1	2	1	1	1	1	1	1	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	22
125	–	–	–	–	–	–	1	–	–	1	–	1	2	1	2	1	2	2	3	3	1	3	2	6	2	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	34
126	–	–	–	–	–	1	–	–	–	–	–	2	–	4	2	3	3	2	5	1	2	6	3	4	5	–	1	–	2	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	47
127	–	–	–	–	1	1	–	1	2	–	–	1	2	1	1	1	1		3	2	6	4	4	4	5	5	1	3	3	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	54
128	–	–	–	–	–	–	–	–	–	–	1	1	–	3	4	8	5	2	11	2	3	8	12	7	5	1	6	5	2	–	–	2	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	90
129	–	–	–	–	–	1	–	1	–	–	1	–	1	3	1	7	4	7	–	6	14	10	10	7	6	6	10	3	10	1	3	–	1	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	115
130	–	–	–	–	–	–	–	–	–	–	–	2	1	6	2	3	7	5	6	10	13	13	12	9	12	14	13	6	3	10	1	3	3	1	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	157
131	–	–	–	–	–	–	1	1	–	1	–	2	–	4	2	5	5	6	14	5	6	19	15	16	14	11	15	4	10	7	4	7	3	5	2	1	2	–	1	–	–	–	–	–	–	–	–	–	–	188
132	–	–	–	–	–	2	–	1	–	–	1	–	1	4	5	4	10	9	10	18	14	12	19	13	21	17	16	14	10	10	8	5	4	2	–	3	1	–	1	–	–	–	–	–	–	–	–	–	–	235
133	–	–	–	–	–	–	–	–	2	–	–	2	3	2	5	9	11	13	7	13	20	19	25	15	22	18	20	10	12	13	9	7	4	5	3	1	1	–	–	–	–	–	–	–	–	–	–	–	–	271
134	–	–	–	–	–	–	–	–	1	–	1	–	1	2	6	7	8	12	18	16	19	24	25	26	25	22	25	26	17	21	10	11	6	2	1	1	1	1	1	1	–	–	–	–	–	–	–	–	–	337
135	–	–	–	–	–	–	–	–	–	–	1	–	1	2	4	4	10	8	10	20	30	20	24	29	27	23	24	26	30	11	18	8	11	5	3	2	2	1	2	1	–	–	–	1	–	–	–	–	–	358
136	–	–	–	–	–	–	–	–	–	–	–	1	1	2	1	1	6	5	9	12	11	16	18	34	24	29	22	20	18	25	14	9	6	10	2	2	3	–	–	–	–	–	–	–	–	–	–	–	–	301
137	–	–	–	–	–	–	–	–	–	–	–	–	2	1	2	2	5	9	11	12	13	21	24	22	23	19	18	20	21	16	13	14	9	5	8	2	2	3	–	1	–	–	–	1	–	–	–	–	–	299
138	–	–	–	–	–	–	–	–	–	–	–	1	1	–	1	1	3	4	6	11	11	18	16	24	23	29	22	31	17	14	11	19	11	6	2	3	1	1	1	1	–	–	–	–	–	–	–	–	–	289
139	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	3	3	5	9	11	10	11	13	24	17	27	20	21	17	15	14	15	10	11	6	4	3	2	1	–	–	–	–	–	–	–	–	–	–	274
140	–	–	–	–	–	–	–	–	–	–	1	–	–	2	1	1	4	3	2	7	18	13	14	20	22	26	25	22	24	19	13	7	15	4	3	3	2	1	–	2	–	–	–	–	–	–	–	–	–	274
141	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	3	–	1	5	10	11	11	16	10	17	22	20	15	6	14	9	13	6	6	2	3	1	2	1	–	–	–	1	–	–	–	–	–	–	206
142	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	1	3	6	3	4	11	10	11	16	15	11	11	19	15	18	7	3	7	6	4	1	2	1	–	–	–	–	–	–	1	–	–	–	189
143	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	2	2	3	2	5	4	7	3	13	13	11	8	15	7	6	11	3	4	4	8	4	4	–	–	2	–	2	–	–	–	–	–	–	144
144	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	3	2	3	5	5	8	12	11	8	8	11	11	7	3	3	7	2	1	1	4	–	2	–	–	–	–	–	–	–	–	–	119
145	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	1	1	4	1	2	8	5	5	8	12	7	7	7	12	8	4	–	2	1	–	2	–	–	–	–	–	–	–	–	–	–	99
146	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	2	–	–	1	3	5	6	4	2	4	5	2	3	6	5	5	2	1	1	1	–	1	–	–	–	1	1	–	–	–	–	–	–	62
147	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	2	3	5	2	2	6	1	3	6	2	5	3	1	2	1	1	1	–	1	–	–	–	–	–	–	–	–	–	48
148	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	1	–	3	1	1	1	2	3	2	3	4	2	1	2	3	2	1	1	2	1	–	–	–	–	–	–	–	–	–	–	–	38
149	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	–	1	2	3	3	2	1	2	1	2	4	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	25
150	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1	–	3	1	–	2	1	5	–	1	3	5	3	–	1	2	–	–	–	–	1	–	–	–	1	–	–	–	–	32
151	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	1	2	2	2	–	2	4	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	16
152	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	1	1	2	2	2	–	1	–	1	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	14
153	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	1	1	1	–	3	–	4	2	1	3	–	1	–	1	1	–	–	–	1	–	–	–	–	–	–	–	22
154	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	1	–	–	–	–	1	–	–	–	1	–	1	–	1	–	–	–	1	–	–	1	–	–	–	–	9
155	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	1	2	1	–	–	–	–	1	1	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	10
156	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
157	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
158	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	2	–	–	–	–	1	–	–	–	–	–	–	–	–	5
159	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
160	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
161	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
162	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
163	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
164	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
165	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1
Totals	–	–	1	1	2	7	4	7	6	2	7	15	18	43	45	72	99	103	151	177	230	265	294	320	330	334	320	289	268	241	188	179	124	90	54	50	32	27	13	11	4	3	4	2	2	1	1	–	–	4436

TABLE V.—TABLE OF HEAD LENGTHS AND HEAD BREADTHS—3951 *Female Inmates.*

Head Length (Millimetres).

Head Breadth (Millimetres).	151	152	154	158	161	163	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	Totals
122	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
123	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
124	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
125	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
126	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
127	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
128	–	–	–	–	1	–	1	–	–	1	–	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
129	–	–	–	–	–	–	–	1	–	–	1	–	–	–	1	–	–	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5
130	–	–	–	–	–	–	–	–	–	–	1	–	–	1	1	–	–	–	–	–	2	–	1	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
131	–	–	–	–	–	–	–	–	–	1	–	–	–	–	3	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6
132	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
133	–	–	–	–	–	–	1	–	–	–	–	–	–	2	3	–	–	2	–	1	1	1	1	–	1	–	2	1	1	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20
134	–	–	–	–	–	–	–	–	–	–	–	1	–	–	2	–	–	3	1	1	1	4	2	2	–	–	1	1	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	21
135	–	–	–	–	–	–	–	–	–	–	–	–	3	1	2	2	–	–	5	1	–	1	1	2	3	3	1	–	–	–	1	1	–	–	2	1	–	–	–	–	–	–	–	–	–	–	–	–	–	30
136	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	2	–	1	3	6	5	4	3	8	1	7	4	–	2	–	1	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	51
137	–	–	–	–	–	–	–	–	–	–	–	2	–	2	–	–	2	2	2	9	2	4	3	8	5	5	3	2	5	2	2	1	1	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	65
138	–	–	–	–	–	–	–	–	–	–	1	1	–	2	1	1	3	5	5	6	8	9	12	7	6	10	8	2	6	1	3	2	3	2	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	106
139	–	–	–	–	–	–	–	–	–	1	1	2	2	1	3	2	4	4	6	10	12	9	5	8	4	12	7	6	3	5	7	5	3	3	1	2	2	1	–	–	–	–	–	–	–	–	–	–	–	131
140	–	–	–	–	–	–	–	1	–	–	–	1	2	2	1	2	1	2	7	5	8	12	12	18	15	10	13	13	8	6	5	12	5	3	–	1	1	–	–	–	1	–	–	–	–	–	–	–	–	167
141	–	–	–	–	–	–	–	–	1	–	–	–	1	1	–	3	2	1	3	7	10	14	18	17	13	16	15	17	14	22	9	12	11	7	2	1	1	–	1	–	–	–	1	–	–	–	–	–	–	220
142	–	–	–	–	–	–	–	–	1	–	–	–	2	–	2	2	3	3	5	8	14	15	13	15	25	24	23	22	20	19	13	13	8	8	6	6	3	1	1	–	1	–	–	–	–	–	–	–	–	276
143	–	–	–	–	–	–	–	–	–	–	2	–	–	–	2	–	1	7	7	9	14	16	16	20	25	20	19	18	23	13	14	14	13	9	12	1	3	2	–	2	1	2	–	1	–	–	–	–	–	286
144	–	–	–	–	–	–	–	–	–	1	–	–	1	2	2	1	2	1	2	6	11	14	17	15	27	28	29	23	20	22	21	12	19	10	12	6	6	5	1	1	–	2	–	–	–	–	–	–	–	319
145	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	2	3	4	6	7	5	15	11	22	23	16	27	28	25	27	26	22	10	12	12	10	6	5	4	2	3	2	2	1	–	–	–	–	–	340
146	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	1	5	2	3	6	10	11	6	27	21	21	21	21	29	20	16	21	16	19	10	7	9	3	4	3	3	2	1	–	–	–	–	–	–	321
147	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	4	2	2	5	9	4	11	14	15	26	18	21	20	24	14	16	16	12	11	11	8	9	–	3	1	3	–	–	–	–	–	–	–	281
148	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	2	–	2	3	3	2	6	12	6	16	12	19	16	25	32	23	17	21	14	15	14	10	9	3	2	–	3	3	–	–	–	–	–	–	291
149	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1	2	2	6	1	8	4	9	5	13	11	18	14	13	17	18	24	18	9	8	9	7	8	8	4	3	1	–	1	–	–	1	–	–	244
150	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	3	3	4	3	4	7	9	14	11	17	15	13	11	14	16	13	1	6	5	8	6	4	1	3	3	–	1	–	–	–	207
151	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	1	1	–	5	1	6	7	6	11	17	11	17	8	11	5	6	8	11	10	11	6	2	–	3	4	1	–	–	–	–	161
152	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	2	2	5	3	4	5	4	10	10	5	8	8	5	12	6	4	3	3	3	3	2	1	–	–	–	1	–	–	110
153	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	2	2	1	2	1	2	5	5	5	6	7	10	6	4	4	6	4	3	1	2	2	2	1	1	–	–	–	1	86
154	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1	2	1	3	4	–	4	–	6	6	4	6	–	5	3	3	3	3	1	2	1	–	–	–	–	59
155	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	2	3	2	1	3	–	1	3	3	2	3	4	4	3	3	2	–	–	–	–	1	–	–	–	41
156	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	1	1	2	1	3	–	5	1	2	2	3	–	2	–	–	1	1	–	–	–	–	–	27
157	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	2	1	–	1	–	1	–	–	1	2	–	1	–	–	1	1	–	–	2	15
158	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1	1	2	2	3	1	–	–	–	1	–	1	1	–	1	–	1	–	–	–	–	–	17
159	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	2	–	–	1	–	–	2	–	–	–	–	–	–	–	1	–	8
160	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–	1	1	–	–	–	–	–	–	–	–	–	4
161	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1	–	1	–	1	–	–	–	–	–	–	–	–	–	4
162	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	2	–	–	–	–	–	3
163	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
164	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
165	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
166	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1
167	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0
178	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
Totals	1	1	1	1	1	1	2	2	2	4	6	8	13	18	30	23	35	48	67	96	127	153	167	207	235	247	261	244	272	259	227	215	199	159	136	113	91	79	46	50	30	25	18	17	4	3	2	1	4	3951

TABLE VI.—TABLE OF HEAD LENGTHS AND HEAD HEIGHTS—3951 *Female Inmates.*

Head Length (Millimetres).

Head Height (Millimetres).

	151	*152*	*154*	*158*	*161*	*163*	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	Totals
106	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
108	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
111	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
112	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
113	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
114	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
115	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
116	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
117	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1	–	1	1	–	1	1	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8
118	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	–	1	–	1	–	1	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
119	–	–	–	–	–	–	–	–	–	2	2	–	–	2	1	1	–	–	–	1	2	1	2	2	1	2	–	–	–	–	1	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22
120	–	–	–	–	1	–	–	–	–	–	–	1	1	–	1	–	1	2	4	2	2	1	2	3	5	5	1	2	–	–	4	1	2	1	–	1	1	–	1	–	–	–	–	–	–	–	–	–	–	45
121	–	–	–	–	–	–	–	–	1	–	–	1	1	–	1	–	1	2	–	4	2	3	2	2	3	2	4	5	1	2	4	–	2	2	1	–	1	1	–	–	–	–	–	–	–	–	–	–	–	48
122	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	3	–	–	4	3	4	4	1	6	3	6	2	3	6	2	1	1	3	2	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	57
123	–	–	–	1	–	–	–	–	–	–	–	1	3	3	2	–	4	1	2	4	7	8	5	10	9	11	8	4	7	2	3	6	4	4	3	1	1	–	–	1	–	–	–	–	–	–	–	–	–	115
124	–	–	–	–	–	–	1	–	–	–	–	1	1	–	–	1	2	1	5	9	8	12	11	11	9	13	9	4	5	6	8	7	4	1	1	–	–	1	1	–	–	–	–	–	–	1	–	–	–	133
125	–	–	–	–	–	–	1	–	–	–	2	–	1	1	3	2	5	2	3	4	8	12	10	9	10	9	13	13	13	12	11	10	5	2	2	3	–	3	–	1	1	–	–	–	–	–	–	–	–	171
126	–	–	–	–	–	–	–	–	–	–	–	1	1	3	4	3	3	2	5	6	9	12	8	10	14	21	20	17	15	6	12	12	4	4	7	5	2	1	–	–	–	–	–	1	–	–	–	–	–	208
127	–	1	–	–	–	–	–	–	–	–	1	–	1	–	2	1	5	2	3	8	9	9	12	11	26	15	16	16	19	23	10	12	14	2	1	4	1	1	1	3	–	1	–	–	–	–	–	–	–	230
128	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	1	5	5	7	8	20	17	19	23	15	15	18	21	21	12	17	8	9	5	9	2	3	1	1	1	2	–	–	–	–	–	–	–	268
129	–	–	–	–	–	–	–	–	–	1	–	1	1	1	1	1	3	5	8	5	12	11	12	17	17	13	24	22	20	17	12	14	10	5	7	5	6	2	2	2	1	–	1	1	1	–	–	–	–	261
130	–	–	–	–	–	–	–	–	–	1	–	–	1	1	1	4	2	5	5	8	13	10	19	19	11	19	17	13	13	12	13	19	17	14	9	12	5	6	1	3	2	2	1	–	–	–	–	–	1	279
131	–	–	–	–	–	–	–	–	–	–	–	1	–	–	4	–	1	3	5	3	8	5	15	13	15	19	22	11	28	15	14	22	18	13	11	6	10	8	5	–	3	2	1	–	–	–	–	–	–	281
132	1	–	–	–	–	–	–	–	–	–	–	1	–	1	1	2	2	1	2	12	5	11	6	14	14	15	28	25	24	23	19	11	16	11	10	9	4	4	2	5	2	2	4	–	1	–	–	–	–	288
133	–	–	–	–	–	–	–	–	1	–	–	–	1	–	2	2	1	3	3	5	7	9	14	13	12	20	22	16	19	25	17	10	12	16	10	4	7	7	2	3	3	–	–	2	–	–	–	–	–	268
134	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	3	1	5	4	2	6	13	13	21	14	11	19	17	21	16	15	15	10	11	8	5	4	5	3	1	–	2	–	1	–	–	–	248
135	–	–	–	–	–	1	–	–	–	–	1	–	–	–	1	–	–	3	1	5	3	2	5	12	10	5	14	13	14	16	13	16	12	9	12	7	9	3	3	3	1	5	2	–	1	–	–	1	1	204
136	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	1	–	2	4	3	6	13	10	11	14	8	19	10	10	12	13	10	9	12	6	1	3	1	3	2	2	1	–	1	–	–	189
137	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	3	3	–	3	3	4	6	2	2	3	11	10	11	11	7	7	10	11	4	4	5	6	4	3	1	–	–	–	–	–	–	–	135
138	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2	1	2	5	3	2	6	5	7	6	7	10	10	7	5	5	10	3	10	8	3	2	1	–	2	1	–	–	–	–	1	125
139	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	1	–	2	4	1	3	2	5	8	5	4	5	10	7	6	3	4	4	5	3	2	1	2	2	2	2	1	–	–	1	–	–	97
140	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	2	1	1	2	7	2	2	6	2	2	8	2	9	3	3	6	2	2	4	3	3	2	1	1	–	1	–	–	–	79
141	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	2	1	1	2	2	1	3	7	2	–	3	4	1	1	4	–	5	1	1	–	–	1	2	–	–	–	–	–	45
142	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	2	–	2	–	3	2	1	–	3	4	1	2	–	–	3	3	1	–	1	–	1	–	–	–	–	–	30
143	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	1	–	2	2	3	1	2	3	1	–	–	–	1	–	–	–	–	2	–	–	–	–	–	20
144	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2	1	1	2	1	–	3	3	1	1	1	1	–	1	1	–	–	–	–	–	–	–	–	20
145	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2	–	–	2	1	1	1	2	–	2	1	2	1	–	–	1	1	–	–	–	–	–	–	–	–	18
146	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	1	–	1	–	2	1	1	–	1	–	–	–	–	–	–	9
147	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	2	–	–	–	–	1	–	1	–	1	–	–	–	–	–	–	–	7
148	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	–	1	–	–	1	–	–	–	2	–	–	–	1	–	–	–	–	–	7
149	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	1	–	–	–	–	–	–	–	–	–	–	4
150	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
151	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	2
152	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2
Totals	1	1	1	1	1	1	2	2	2	4	6	8	13	18	30	23	35	48	67	96	127	153	167	207	235	247	261	244	272	259	227	215	199	159	136	113	91	79	46	50	30	25	18	17	4	3	2	1	4	3951

TABLE VII.—TABLE OF HEAD HEIGHTS AND HEAD BREADTHS—3951 *Female Inmates.*

Head Height (Millimetres).

Head Breadth (Millimetres).

	122	123	124	125	126	127	128	129	130	131	132	133	134	135	156	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	Totals
106	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
108	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
111	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
112	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
113	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
114	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
115	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
116	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
117	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	3	1	–	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8
118	–	–	–	–	–	–	–	1	–	–	–	–	–	1	–	–	1	–	1	–	–	–	–	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
119	–	–	–	–	–	–	–	1	2	2	–	–	–	–	2	1	3	2	1	1	–	–	2	–	–	2	2	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	22
120	–	–	–	–	–	–	1	–	–	–	–	1	2	1	2	–	1	5	4	4	6	4	5	2	4	–	–	–	–	1	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	45
121	–	–	–	–	–	–	–	1	–	–	–	2	–	1	1	5	–	2	1	2	6	7	7	5	3	2	1	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	48
122	–	–	–	–	–	–	–	–	1	–	–	1	1	2	1	5	2	3	3	5	6	8	2	5	4	1	2	2	2	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	57
123	–	–	–	–	–	–	–	–	1	–	1	–	2	4	1	7	8	6	4	10	11	8	8	10	9	8	5	1	5	1	3	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	115
124	–	–	–	–	–	–	1	–	–	–	–	2	2	5	7	3	6	9	10	8	13	10	14	8	8	7	9	1	4	3	2	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	133
125	–	–	1	1	–	–	–	–	–	1	–	2	1	1	2	2	6	8	10	13	18	10	10	22	12	8	9	11	9	4	2	4	1	2	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	171
126	–	–	–	–	–	–	1	1	2	–	–	3	1	1	4	8	10	6	11	9	17	13	18	18	23	13	12	7	11	8	5	3	2	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	208
127	–	–	–	–	–	1	–	–	–	1	1	3	2	2	4	7	13	5	11	19	20	20	18	16	18	18	13	16	8	4	5	2	2	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	230
128	–	–	–	–	–	–	–	–	–	–	–	1	3	–	4	4	6	14	17	17	25	20	21	26	26	14	20	13	13	9	5	4	2	1	2	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	268
129	–	–	–	–	–	–	1	–	–	–	–	2	1	1	3	2	11	15	8	19	19	23	23	32	18	20	14	13	11	11	2	9	1	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	261
130	–	–	–	–	–	–	1	1	–	–	–	–	2	2	1	3	4	9	12	16	21	28	27	25	26	21	17	16	12	13	9	3	3	3	1	1	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	279
131	–	–	–	–	–	–	–	–	–	–	1	1	–	2	5	4	7	9	17	21	17	11	22	23	22	23	21	18	15	14	6	7	7	5	–	1	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	281
132	–	–	–	–	–	–	–	–	–	1	3	1	1	1	4	2	9	10	11	17	16	15	29	23	20	27	23	22	17	15	6	7	3	–	1	–	1	2	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	288
133	–	–	–	–	1	–	–	–	–	–	–	1	1	2	2	2	4	5	9	18	18	25	30	21	18	21	24	26	6	8	7	10	1	4	–	1	2	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	268
134	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	5	2	3	8	11	17	20	23	21	16	22	27	17	9	10	11	6	3	5	4	2	3	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	248
135	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	3	6	7	5	10	9	14	23	21	10	23	16	14	11	7	4	7	2	6	4	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	204
136	–	–	–	–	–	–	–	–	–	–	–	–	–	1	4	–	1	1	6	2	12	13	15	20	18	17	11	14	12	14	8	6	4	7	2	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	189
137	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	2	1	5	6	6	12	7	9	13	10	11	11	14	5	5	4	6	1	3	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	135
138	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	1	3	4	3	6	6	5	3	11	11	11	13	10	11	5	5	6	4	–	1	2	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	125
139	–	–	1	–	–	–	–	–	–	–	–	–	1	–	–	2	1	2	–	2	6	6	6	4	9	7	7	10	11	4	8	4	1	–	2	–	1	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	97
140	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	1	3	2	5	9	6	4	7	6	7	6	9	4	1	1	3	1	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	79
141	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	3	1	2	7	2	4	4	4	2	5	3	4	–	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	45
142	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	1	2	1	2	3	1	6	2	2	2	1	2	–	1	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
143	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	3	1	1	1	5	1	1	3	–	1	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20
144	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	2	1	–	–	1	–	1	3	2	–	2	–	–	3	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20
145	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	2	–	1	2	1	2	1	2	1	1	–	–	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18
146	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	3	–	1	–	1	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9
147	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	2	–	1	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7
148	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	1	1	–	–	2	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	7
149	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	–	–	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4
150	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
151	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
152	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2
Totals	1	1	2	1	1	1	5	5	7	6	7	20	21	30	51	65	106	131	167	220	276	286	319	340	321	281	291	244	207	161	110	86	59	41	27	15	17	8	4	4	3	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	3951

TABLE VIII.

Table of Hair and Eye Colours.

4235 *Males and* 3708 *Females.*

MALES.

HAIR COLOUR.

		Red	Fair	Medium	Dark	Total	Per cent.
EYE COLOUR.	Light	37	175	1345	346	1903	44·94
	Medium	20	77	788	497	1382	32·63
	Dark	9	23	389	529	950	22·43
	Total	66	275	2522	1372	4235	100
	Per cent.	1·56	6·49	59·55	32·40	100	—

FEMALES.

HAIR COLOUR.

		Red	Fair	Medium	Dark	Total	Per cent.
EYE COLOUR.	Light	28	72	998	347	1445	38·97
	Medium	46	31	642	564	1283	34·60
	Dark	15	4	369	592	980	26·43
	Total	89	107	2009	1503	3708	100
	Per cent.	2·40	2·89	54·18	40·53	100	—

TABLE IX.

4401 *Males.*

Head Length (Millimetres).

Stature (Inches).	Up to *172*	*173—177*	*178—182*	*183—187*	*188—192*	*193—197*	*198—202*	*203—207*	*208—212*	*213—217*	*218* & over	Totals
Up to *50*	—	—	—	2	1	2	—	—	—	—	—	5
52	1	—	1	—	1	—	—	—	—	—	—	3
54	—	—	—	1	—	1	—	—	—	—	—	2
56	—	1	—	—	3	2	—	1	—	—	—	7
58	—	4	4	6	9	4	3	2	—	—	—	32
60	2	1	9	19	19	15	8	3	—	—	1	77
62	2	3	18	56	83	71	47	15	2	1	1	299
64	—	6	22	90	205	195	129	32	12	—	—	691
66	2	6	23	102	280	374	297	105	29	3	—	1221
68	—	—	16	60	217	382	327	155	47	4	1	1209
70	—	1	6	19	77	168	183	99	28	8	—	589
72	—	1	1	3	25	66	67	42	12	1	2	220
74	—	—	—	—	5	19	5	7	6	2	—	44
76	—	—	—	—	—	—	—	1	—	—	1	2
Totals	7	23	100	358	925	1299	1066	462	136	19	6	4401

TABLE X.

4401 *Males.*

Head Breadth (Millimetres).

Stature (Inches).	*128—132*	*133—137*	*138—142*	*143—147*	*148—152*	*153—157*	*158—162*	*163—167*	*168—172*	*173* & over	Totals
Up to *50*	—	—	—	2	1	1	1	—	—	—	5
52	—	—	1	2	—	—	—	—	—	—	3
54	—	—	—	—	2	—	—	—	—	—	2
56	—	—	2	2	1	—	1	1	—	—	7
58	1	3	3	7	9	7	2	—	—	—	32
60	—	1	12	24	25	11	3	—	—	1	77
62	5	6	33	69	93	64	25	2	2	—	299
64	—	8	44	152	265	175	42	5	—	—	691
66	3	6	51	212	447	355	127	19	1	—	1221
68	1	2	30	198	410	382	155	28	2	1	1209
70	—	—	9	61	195	206	96	18	4	—	589
72	—	—	6	25	66	78	33	11	1	—	220
74	—	—	—	2	18	13	7	3	1	—	44
76	—	—	—	—	—	1	1	—	—	—	2
Totals	10	26	191	756	1532	1293	493	87	11	2	4401

TABLE XI.

4401 *Males.*

Head Height (Millimetres).

Stature (Inches).	*Up to 117*	*118—122*	*123—127*	*128—132*	*133—137*	*138—142*	*143—147*	*148—152*	*153—157*	*158—162*	*163 & over*	Totals
Up to *50*	—	—	—	3	2	—	—	—	—	—	—	5
52	—	—	—	1	2	—	—	—	—	—	—	3
54	—	—	—	—	2	—	—	—	—	—	—	2
56	—	—	1	1	3	2	—	—	—	—	—	7
58	—	1	4	11	11	3	2	—	—	—	—	32
60	—	5	3	22	28	13	2	1	1	1	1	77
62	2	4	31	84	97	58	16	3	4	—	—	299
64	1	3	44	154	239	188	47	13	1	1	—	691
66	—	8	46	232	434	342	125	23	11	—	—	1221
68	—	4	27	187	446	339	151	40	12	3	—	1209
70	—	—	7	57	208	187	87	31	11	1	—	589
72	—	—	5	21	68	80	29	12	3	2	—	220
74	—	—	—	2	12	15	10	2	2	1	—	44
76	—	—	—	1	—	—	—	—	—	1	—	2
Totals	3	25	168	776	1552	1227	469	125	45	10	1	4401

TABLE XII.

3915 *Females.*

Head Length (Millimetres).

Stature (Inches).	Up to *172*	*173—177*	*178—182*	*183—187*	*188—192*	*193—197*	*198—202*	*203—207*	Totals
Up to *50*	2	2	3	6	1	3	—	—	17
52	2	—	4	2	1	—	—	—	9
54	1	1	3	10	1	1	—	—	17
56	6	12	23	25	15	4	1	—	86
58	16	44	94	102	78	26	6	—	366
60	12	57	178	315	203	73	20	2	860
62	13	55	251	423	348	127	35	1	1253
64	8	23	131	265	257	144	39	7	874
66	—	6	37	81	111	65	23	4	327
68	—	2	12	22	31	11	12	—	90
70	—	—	3	1	3	—	3	—	10
72	—	1	—	—	2	1	—	—	4
74	—	—	1	—	—	1	—	—	2
Totals	60	203	740	1252	1051	456	139	14	3915

TABLE XIII.

3915 *Females.*

Head Breadth (Millimetres).

Stature (Inches).	Up to *127*	*128—132*	*133—137*	*138—142*	*143—147*	*148—152*	*153—157*	*158—162*	*163—167*	*168—172*	*173* & over	Totals
Up to *50*	1	1	1	6	6	2	—	—	—	—	—	17
52	—	1	2	4	1	1	—	—	—	—	—	9
54	—	—	4	3	6	4	—	—	—	—	—	17
56	—	5	8	30	28	13	2	—	—	—	—	86
58	2	7	35	105	140	64	11	2	—	—	—	366
60	1	6	47	223	351	193	32	6	1	—	—	860
62	2	7	51	294	499	323	69	7	1	—	—	1253
64	1	2	29	166	337	264	64	10	—	—	1	874
66	—	—	6	47	125	104	37	8	—	—	—	327
68	—	—	3	12	37	30	6	2	—	—	—	90
70	—	—	—	1	4	3	1	1	—	—	—	10
72	—	—	—	3	—	—	1	—	—	—	—	4
74	—	—	—	—	1	1	—	—	—	—	—	2
Totals	7	29	186	894	1535	1002	223	36	2	—	1	3915

TABLE XIV.

3915 *Females.*

Head Height (Millimetres).

Stature (Inches).	Up to *117*	*118—122*	*123—127*	*128—132*	*133—137*	*138—142*	*143—147*	*148—152*	Totals
Up to *50*	1	1	5	4	5	1	—	—	17
52	1	2	1	3	2	—	—	—	9
54	—	—	9	5	2	1	—	—	17
56	3	7	28	33	12	3	—	—	86
58	4	29	111	133	69	17	2	1	366
60	10	48	221	321	178	69	11	2	860
62	4	58	271	438	352	104	23	3	1253
64	2	22	143	298	271	108	22	8	874
66	—	6	40	100	124	47	9	1	327
68	—	—	11	28	23	20	7	1	90
70	—	—	2	3	1	3	—	1	10
72	1	—	1	1	1	—	—	—	4
74	—	—	—	1	1	—	—	—	2
Totals	26	173	843	1368	1041	373	74	17	3915

TABLE XV.—Head Length.—Individual Asylums.

Asylums	MALES			FEMALES		
	Mean	Standard Deviation	Coefficient of Variation	Mean	Standard Deviation	Coefficient of Variation
Aberdeen ...	193·9 ± ·24	6·19 ± ·17	3·20 ± ·09	185·8 ± ·26	6·60 ± ·18	3·55 ± ·10
Dumfries ...	196·4 ± ·47	7·34 ± ·33	3·74 ± ·17	187·1 ± ·34	6·11 ± ·24	3·27 ± ·13
Dundee ...	195·1 ± ·39	6·82 ± ·28	3·49 ± ·14	185·9 ± ·30	6·20 ± ·21	3·33 ± ·11
Edinburgh ...	194·3 ± ·32	6·26 ± ·23	3·22 ± ·12	185·3 ± ·27	5·68 ± ·19	3·06 ± ·10
Montrose ...	194·8 ± ·28	6·60 ± ·20	3·39 ± ·10	185·5 ± ·33	5·94 ± ·23	3·20 ± ·12
Argyll ...	199·3 ± ·33	6·72 ± ·23	3·37 ± ·12	189·0 ± ·29	5·97 ± ·20	3·16 ± ·11
Ayr ...	197·7 ± ·25	5·67 ± ·18	2·87 ± ·09	188·0 ± ·26	6·01 ± ·18	3·20 ± ·10
Banff ...	195·6 ± ·46	6·15 ± ·32	3·14 ± ·17	185·3 ± ·45	5·26 ± ·32	2·84 ± ·17
Elgin ...	194·4 ± ·47	5·81 ± ·33	2·99 ± ·17	184·8 ± ·43	5·98 ± ·30	3·24 ± ·16
Fife ...	195·7 ± ·30	6·45 ± ·21	3·30 ± ·11	187·0 ± ·28	5·99 ± ·20	3·20 ± ·11
Glasgow (Gartloch)	195·3 ± ·25	6·24 ± ·18	3·19 ± ·09	185·6 ± ·31	5·96 ± ·22	3·21 ± ·12
,, (Lenzie)	193·7 ± ·23	6·51 ± ·16	3·36 ± ·08	186·5 ± ·22	5·58 ± ·16	2·99 ± ·09
Govan ...	195·8 ± ·27	6·50 ± ·19	3·32 ± ·10	185·8 ± ·28	5·74 ± ·20	3·09 ± ·11
Haddington ...	194·9 ± ·51	6·21 ± ·36	3·19 ± ·19	186·7 ± ·47	5·92 ± ·33	3·17 ± ·18
Inverness ...	195·9 ± ·25	6·25 ± ·18	3·19 ± ·09	187·2 ± ·26	5·95 ± ·18	3·18 ± ·10
Lanark ...	196·2 ± ·21	6·05 ± ·15	3·09 ± ·08	187·0 ± ·21	5·94 ± ·15	3·18 ± ·08
Midlothian ...	194·2 ± ·36	6·01 ± ·25	3·10 ± ·13	185·7 ± ·37	6·45 ± ·26	3·47 ± ·14
Perth ...	195·3 ± ·34	6·54 ± ·24	3·35 ± ·12	186·6 ± ·40	6·09 ± ·28	3·27 ± ·15
Roxburgh ...	195·2 ± ·37	6·42 ± ·26	3·29 ± ·14	186·0 ± ·32	5·50 ± ·23	2·96 ± ·12
Stirling ...	195·4 ± ·26	6·72 ± ·18	3·44 ± ·09	186·5 ± ·25	5·83 ± ·18	3·13 ± ·10
Greenock ...	195·6 ± ·42	6·70 ± ·29	3·43 ± ·15	185·2 ± ·36	5·31 ± ·25	2·87 ± ·14
Paisley ...	196·7 ± ·49	6·89 ± ·34	3·51 ± ·18	187·1 ± ·44	6·24 ± ·31	3·34 ± ·17
General Population	195·5 ± ·07	6·55 ± ·05	3·35 ± ·02	186·5 ± ·07	6·04 ± ·05	3·24 ± ·03

TABLE XVI.—Head Breadth.—Individual Asylums.

Asylums	MALES			FEMALES		
	Mean	Standard Deviation	Coefficient of Variation	Mean	Standard Deviation	Coefficient of Variation
Aberdeen ...	152·1 ± ·19	4·94 ± ·13	3·25 ± ·09	145·9 ± ·19	4·93 ± ·14	3·38 ± ·09
Dumfries ...	151·3 ± ·39	6·07 ± ·27	4·01 ± ·18	145·5 ± ·28	4·89 ± ·19	3·36 ± ·13
Dundee ...	152·1 ± ·30	5·30 ± ·21	3·49 ± ·14	145·2 ± ·24	4·99 ± ·17	3·44 ± ·12
Edinburgh ...	150·9 ± ·27	5·24 ± ·19	3·47 ± ·13	144·3 ± ·24	5·10 ± ·17	3·53 ± ·12
Montrose ...	152·5 ± ·22	5·18 ± ·16	3·40 ± ·10	146·9 ± ·31	5·57 ± ·22	3·79 ± ·15
Argyll ...	153·1 ± ·27	5·52 ± ·19	3·61 ± ·13	145·8 ± ·22	4·49 ± ·15	3·08 ± ·11
Ayr ...	152·3 ± ·21	4·71 ± ·15	3·10 ± ·10	145·5 ± ·23	5·32 ± ·16	3·65 ± ·11
Banff ...	153·2 ± ·42	5·57 ± ·29	3·64 ± ·19	147·4 ± ·33	3·83 ± ·23	2·60 ± ·16
Elgin ...	152·5 ± ·42	5·30 ± ·30	3·48 ± ·20	145·8 ± ·34	4·81 ± ·24	3·30 ± ·17
Fife ...	151·7 ± ·24	5·12 ± ·17	3·38 ± ·11	145·8 ± ·24	5·10 ± ·17	3·50 ± ·12
Glasgow (Gartloch)	150·5 ± ·21	5·18 ± ·15	3·44 ± ·10	143·8 ± ·24	4·61 ± ·17	3·20 ± ·12
,, (Lenzie)	150·0 ± ·20	5·59 ± ·14	3·73 ± ·09	144·5 ± ·17	4·30 ± ·12	2·98 ± ·09
Govan ...	150·8 ± ·23	5·56 ± ·16	3·69 ± ·11	144·6 ± ·22	4·48 ± ·16	3·10 ± ·11
Haddington ...	151·5 ± ·45	5·48 ± ·32	3·62 ± ·21	144·5 ± ·40	5·04 ± ·28	3·49 ± ·20
Inverness ...	152·9 ± ·20	4·93 ± ·14	3·22 ± ·09	146·7 ± ·19	4·36 ± ·13	2·97 ± ·09
Lanark ...	151·5 ± ·18	5·23 ± ·13	3·46 ± ·09	145·2 ± ·17	4·84 ± ·12	3·33 ± ·08
Midlothian ...	150·9 ± ·35	5·86 ± ·25	3·88 ± ·16	144·3 ± ·28	4·91 ± ·20	3·41 ± ·14
Perth ...	152·0 ± ·28	5·32 ± ·20	3·50 ± ·13	145·7 ± ·33	4·96 ± ·23	3·41 ± ·16
Roxburgh ...	151·2 ± ·31	5·35 ± ·22	3·54 ± ·15	145·0 ± ·29	4·98 ± ·21	3·43 ± ·14
Stirling ...	150·9 ± ·21	5·53 ± ·15	3·67 ± ·10	144·9 ± ·21	4·80 ± ·15	3·31 ± ·10
Greenock ...	151·1 ± ·37	5·90 ± ·26	3·91 ± ·17	144·5 ± ·34	4·97 ± ·24	3·44 ± ·16
Paisley ...	151·0 ± ·33	4·74 ± ·24	3·14 ± ·16	145·8 ± ·33	4·78 ± ·24	3·28 ± ·16
General Population	151·5 ± ·06	5·39 ± ·04	3·56 ± ·03	145·3 ± ·05	4·91 ± ·04	3·38 ± ·03

TABLE XVII.—HEAD HEIGHT.—INDIVIDUAL ASYLUMS.

Asylums	MALES			FEMALES		
	Mean	Standard Deviation	Coefficient of Variation	Mean	Standard Deviation	Coefficient of Variation
Aberdeen ...	135·8 ± ·20	5·21 ± ·14	3·84 ± ·10	131·2 ± ·25	6·37 ± ·18	4·86 ± ·14
Dumfries ...	135·0 ± ·34	5·29 ± ·24	3·92 ± ·18	129·1 ± ·23	4·03 ± ·16	3·12 ± ·12
Dundee ...	134·0 ± ·25	4·31 ± ·17	3·22 ± ·13	129·9 ± ·21	4·48 ± ·15	3·45 ± ·12
Edinburgh ...	139·0 ± ·28	5·58 ± ·20	4·02 ± ·14	133·4 ± ·25	5·31 ± ·18	3·98 ± ·13
Montrose ...	139·2 ± ·25	5·84 ± ·18	4·19 ± ·13	132·1 ± ·36	6·54 ± ·25	4·95 ± ·19
Argyll ...	135·2 ± ·23	4·71 ± ·16	3·48 ± ·12	130·0 ± ·20	4·24 ± ·14	3·26 ± ·11
Ayr ...	135·9 ± ·19	4·18 ± ·13	3·07 ± ·10	129·4 ± ·18	4·04 ± ·12	3·13 ± ·10
Banff ...	136·0 ± ·40	5·43 ± ·29	3·99 ± ·21	130·3 ± ·42	4·94 ± ·30	3·79 ± ·23
Elgin ...	134·5 ± ·49	6·06 ± ·34	4·51 ± ·26	128·4 ± ·37	5·19 ± ·26	4·04 ± ·21
Fife ...	135·6 ± ·19	4·14 ± ·14	3·05 ± ·10	129·7 ± ·22	4·75 ± ·16	3·66 ± ·12
Glasgow (Gartloch)	135·2 ± ·18	4·46 ± ·13	3·30 ± ·09	128·7 ± ·25	4·79 ± ·18	3·72 ± ·14
„ (Lenzie)	135·5 ± ·17	4·74 ± ·12	3·50 ± ·09	130·9 ± ·19	4·64 ± ·13	3·55 ± ·10
Govan ...	135·7 ± ·21	4·96 ± ·15	3·66 ± ·11	131·5 ± ·20	4·12 ± ·14	3·14 ± ·11
Haddington ...	137·2 ± ·57	6·93 ± ·40	5·06 ± ·30	134·5 ± ·41	5·20 ± ·29	3·87 ± ·22
Inverness ...	135·6 ± ·27	6·73 ± ·19	4·96 ± ·14	128·0 ± ·24	5·67 ± ·17	4·43 ± ·14
Lanark ...	138·3 ± ·18	5·19 ± ·13	3·75 ± ·09	131·7 ± ·18	5·11 ± ·13	3·88 ± ·10
Midlothian ...	139·5 ± ·32	5·36 ± ·23	3·84 ± ·16	133·6 ± ·33	5·85 ± ·23	4·38 ± ·18
Perth ...	139·6 ± ·34	6·43 ± ·24	4·61 ± ·17	133·3 ± ·26	4·17 ± ·19	3·13 ± ·15
Roxburgh ...	138·7 ± ·35	6·00 ± ·25	4·33 ± ·18	134·0 ± ·34	5·91 ± ·24	4·41 ± ·18
Stirling ...	139·2 ± ·23	5·93 ± ·16	4·26 ± ·12	133·6 ± ·24	5·61 ± ·17	4·20 ± ·13
Greenock ...	133·8 ± ·29	4·64 ± ·20	3·47 ± ·15	128·9 ± ·30	4·44 ± ·25	3·44 ± ·17
Paisley ...	137·2 ± ·28	3·93 ± ·20	2·87 ± ·14	132·9 ± ·35	4·94 ± ·24	3·72 ± ·18
General Population	136·7 ± ·06	5·58 ± ·04	4·08 ± ·03	131·0 ± ·06	5·43 ± ·04	4·14 ± ·03

TABLE XVIII.—CEPHALIC INDEX.—INDIVIDUAL ASYLUMS.

Asylums	MALES			FEMALES		
	Mean	Standard Deviation	Coefficient of Variation	Mean	Standard Deviation	Coefficient of Variation
Aberdeen ...	78·5 ± ·10	2·57 ± ·07	3·27 ± ·09	78·6 ± ·11	2·81 ± ·08	3·58 ± ·10
Dumfries ...	77·1 ± ·19	3·04 ± ·14	3·94 ± ·18	77·8 ± ·15	2·66 ± ·11	3·42 ± ·14
Dundee ...	78·0 ± ·16	2·76 ± ·11	3·54 ± ·14	78·1 ± ·13	2·74 ± ·09	3·50 ± ·12
Edinburgh ...	77·7 ± ·13	2·64 ± ·10	3·40 ± ·12	77·9 ± ·13	2·67 ± ·09	3·43 ± ·11
Montrose ...	78·3 ± ·12	2·70 ± ·08	3·45 ± ·10	79·2 ± ·16	2·89 ± ·11	3·64 ± ·14
Argyll ...	76·8 ± ·13	2·73 ± ·10	3·55 ± ·12	77·2 ± ·12	2·49 ± ·09	3·22 ± ·11
Ayr ...	77·1 ± ·10	2·34 ± ·07	3·04 ± ·10	77·4 ± ·12	2·75 ± ·08	3·56 ± ·11
Banff ...	78·4 ± ·20	2·72 ± ·14	3·47 ± ·18	79·6 ± ·19	2·24 ± ·14	2·82 ± ·17
Elgin ...	78·5 ± ·21	2·60 ± ·15	3·31 ± ·19	78·9 ± ·19	2·67 ± ·14	3·38 ± ·17
Fife ...	77·6 ± ·12	2·63 ± ·09	3·39 ± ·11	78·0 ± ·13	2·71 ± ·09	3·47 ± ·12
Glasgow (Gartloch)	77·1 ± ·10	2·61 ± ·07	3·38 ± ·10	77·5 ± ·14	2·56 ± ·10	3·31 ± ·12
„ (Lenzie)	77·5 ± ·10	2·80 ± ·07	3·61 ± ·09	77·5 ± ·10	2·39 ± ·07	3·08 ± ·09
Govan ...	77·1 ± ·11	2·75 ± ·08	3·57 ± ·11	77·9 ± ·12	2·49 ± ·09	3·20 ± ·11
Haddington ...	77·8 ± ·22	2·70 ± ·16	3·48 ± ·20	77·4 ± ·21	2·67 ± ·15	3·45 ± ·19
Inverness ...	78·1 ± ·10	2·54 ± ·07	3·25 ± ·09	78·5 ± ·11	2·50 ± ·08	3·18 ± ·10
Lanark ...	77·3 ± ·09	2·58 ± ·06	3·34 ± ·08	77·7 ± ·09	2·61 ± ·07	3·36 ± ·09
Midlothian ..	77·7 ± ·17	2·80 ± ·12	3·61 ± ·15	77·8 ± ·16	2·77 ± ·11	3·56 ± ·14
Perth ...	77·9 ± ·14	2·71 ± ·10	3·48 ± ·13	78·1 ± ·18	2·70 ± ·13	3·45 ± ·17
Roxburgh ...	77·5 ± ·16	2·69 ± ·11	3·47 ± ·14	78·0 ± ·15	2·59 ± ·11	3·32 ± ·15
Stirling ...	77·3 ± ·11	2·79 ± ·08	3·61 ± ·10	77·7 ± ·11	2·59 ± ·08	3·33 ± ·11
Greenock ...	77·3 ± ·18	2·90 ± ·13	3·75 ± ·17	78·1 ± ·17	2·57 ± ·12	3·29 ± ·17
Paisley ...	76·8 ± ·18	2·60 ± ·13	3·39 ± ·17	78·0 ± ·19	2·67 ± ·13	3·42 ± ·18
General Population	77·6 ± ·03	2·72 ± ·02	3·51 ± ·03	78·0 ± ·03	2·67 ± ·02	3·42 ± ·03

TABLE XIX.—STATURE.—INDIVIDUAL ASYLUMS.

Asylums	MALES			FEMALES		
	Mean Inches	Standard Deviation	Coefficient of Variation	Mean Inches	Standard Deviation	Coefficient of Variation
Aberdeen ...	66·3 ± ·11	2·78 ± ·08	4·19 ± ·12	61·3 ± ·10	2·52 ± ·07	4·12 ± ·12
Dumfries ...	66·0 ± ·17	2·72 ± ·12	4·12 ± ·19	61·5 ± ·14	2·43 ± ·10	3·95 ± ·16
Dundee ...	65·5 ± ·15	2·60 ± ·11	3·97 ± ·16	60·9 ± ·12	2·45 ± ·08	4·03 ± ·14
Edinburgh ...	65·8 ± ·15	3·03 ± ·11	4·61 ± ·16	61·0 ± ·12	2·56 ± ·09	4·19 ± ·14
Montrose ...	66·3 ± ·11	2·60 ± ·08	3·93 ± ·12	61·0 ± ·14	2·53 ± ·10	4·15 ± ·16
Argyll ...	66·8 ± ·14	2·87 ± ·10	4·29 ± ·15	61·6 ± ·12	2·56 ± ·09	4·15 ± ·14
Ayr ...	65·7 ± ·13	2·86 ± ·09	4·35 ± ·14	60·9 ± ·11	2·66 ± ·08	4·37 ± ·13
Banff ...	66·4 ± ·22	2·96 ± ·15	4·46 ± ·23	62·1 ± ·22	2·56 ± ·16	4·13 ± ·25
Elgin ...	65·7 ± ·24	2·96 ± ·17	4·50 ± ·26	62·1 ± ·19	2·51 ± ·13	4·05 ± ·21
Fife ...	65·9 ± ·10	2·24 ± ·07	3·40 ± ·11	61·7 ± ·11	2·27 ± ·08	3·69 ± ·12
Glasgow (Gartloch)	65·3 ± ·12	2·92 ± ·08	4·47 ± ·13	60·7 ± ·15	2·74 ± ·10	4·52 ± ·17
„ (Lenzie)	64·7 ± ·11	3·03 ± ·08	4·68 ± ·12	60·3 ± ·10	2·45 ± ·07	4·06 ± ·12
Govan ...	66·2 ± ·13	3·02 ± ·09	4·56 ± ·13	61·2 ± ·13	2·59 ± ·09	4·23 ± ·15
Haddington ...	66·6 ± ·25	3·05 ± ·18	4·58 ± ·27	61·7 ± ·21	2·68 ± ·15	4·34 ± ·24
Inverness ...	66·4 ± ·10	2·59 ± ·07	3·90 ± ·11	62·0 ± ·11	2·50 ± ·08	4·03 ± ·13
Lanark ...	65·7 ± ·09	2·64 ± ·06	4·02 ± ·10	61·2 ± ·09	2·62 ± ·07	4·29 ± ·11
Midlothian ...	66·2 ± ·15	2·51 ± ·10	3·80 ± ·16	61·2 ± ·14	2·51 ± ·10	4·11 ± ·17
Perth ...	66·2 ± ·14	2·79 ± ·10	4·22 ± ·15	61·2 ± ·16	2·37 ± ·11	3·87 ± ·18
Roxburgh ...	66·5 ± ·15	2·62 ± ·11	3·95 ± ·16	61·6 ± ·14	2·41 ± ·10	3·90 ± ·16
Stirling ...	65·6 ± ·11	2·74 ± ·07	4·17 ± ·11	60·6 ± ·11	2·65 ± ·08	4·37 ± ·13
Greenock ...	65·5 ± ·19	3·04 ± ·13	4·63 ± ·20	60·3 ± ·17	2·43 ± ·12	4·03 ± ·19
Paisley ...	65·5 ± ·21	3·01 ± ·15	4·59 ± ·23	61·5 ± ·17	2·43 ± ·12	3·95 ± ·20
General Population	65·9 ± ·03	2·84 ± ·02	4·31 ± ·03	61·2 ± ·03	2·58 ± ·02	4·22 ± ·03

TABLE XX.—H.L.B. PRODUCT.—INDIVIDUAL ASYLUMS.

Asylums	MALES		FEMALES	
	Mean cm.^{3} = 1 unit	Standard Deviation	Mean cm.^{3} = 1 unit	Standard Deviation
Aberdeen ...	4008 ± 12	319·2 ± 8·6	3565 ± 13	321·1 ± 8·9
Dumfries ...	4020 ± 23	363·6 ± 16·3	3517 ± 15	262·6 ± 10·4
Dundee ...	3981 ± 18	315·3 ± 12·8	3512 ± 13	274·5 ± 9·3
Edinburgh ...	4083 ± 17	338·5 ± 12·1	3573 ± 14	288·7 ± 9·6
Montrose ...	4141 ± 15	352·2 ± 10·6	3605 ± 18	329·7 ± 12·8
Argyll ...	4132 ± 16	335·2 ± 11·7	3586 ± 13	260·6 ± 8·9
Ayr ...	4094 ± 13	287·0 ± 9·0	3541 ± 12	270·9 ± 8·3
Banff ...	4084 ± 25	340·6 ± 17·9	3564 ± 22	251·7 ± 15·3
Elgin ...	3992 ± 27	339·7 ± 19·2	3466 ± 20	280·1 ± 14·2
Fife ...	4029 ± 14	304·4 ± 10·0	3542 ± 13	280·5 ± 9·3
Glasgow (Gartloch)	3977 ± 12	306·7 ± 8·6	3438 ± 14	266·2 ± 9·9
„ (Lenzie)	3942 ± 11	323·6 ± 8·1	3531 ± 10	256·8 ± 7·3
Govan ...	4012 ± 14	331·5 ± 9·7	3535 ± 12	252·3 ± 8·8
Haddington ...	4058 ± 31	373·5 ± 21·8	3633 ± 23	292·3 ± 16·3
Inverness ...	4068 ± 14	359·5 ± 10·1	3519 ± 12	284·9 ± 8·7
Lanark ...	4114 ± 11	328·2 ± 8·0	3580 ± 10	284·1 ± 7·2
Midlothian ...	4093 ± 20	343·5 ± 14·5	3584 ± 18	308·3 ± 12·4
Perth ...	4149 ± 19	368·3 ± 13·6	3627 ± 18	272·3 ± 12·7
Roxburgh ...	4098 ± 21	354·1 ± 14·5	3618 ± 17	290·0 ± 12·3
Stirling ...	4111 ± 14	361·8 ± 9·8	3615 ± 13	294·0 ± 8·9
Greenock ...	3960 ± 21	332·0 ± 14·6	3453 ± 17	257·5 ± 12·3
Paisley ...	4077 ± 21	302·0 ± 15·0	3631 ± 20	286·7 ± 14·2
General Population	4055 ± 4	345·0 ± 2·5	3555 ± 3	292·2 ± 2·2

TABLE XXI.

$\frac{H}{B}$ INDEX, $\frac{H}{L}$ INDEX AND L.B. PRODUCT.—INDIVIDUAL ASYLUMS.—*Males.*

Asylums	$\frac{H}{B}$ Index		$\frac{H}{L}$ Index		L.B. Product mm.^{2}=1 unit	
	Mean	S. D.	Mean	S. D.	Mean	S. D.
Aberdeen ...	89·3±·14	3·63±·10	70·1±·11	2·78±·08	29494± 62	1639± 44
Dumfries ...	89·3±·26	4·03±·18	68·8±·19	2·94±·13	29746±126	1987± 89
Dundee ...	88·2±·19	3·37±·14	68·7±·15	2·58±·10	29696±102	1786± 72
Edinburgh ...	92·2±·20	3·95±·14	71·6±·15	2·93±·11	29337± 86	1692± 61
Montrose ...	91·3±·17	3·99±·12	71·5±·13	3·07±·09	29725± 74	1739± 52
Argyll ...	88·4±·18	3·57±·12	67·9±·13	2·60±·09	30529± 90	1837± 64
Ayr ...	89·3±·14	3·13±·10	68·8±·10	2·29±·07	30113± 69	1550± 49
Banff ...	88·9±·29	3·86±·20	69·6±·21	2·82±·15	29990±131	1754± 92
Elgin ...	88·3±·33	4·08±·23	69·2±·24	3·03±·17	29651±132	1655± 94
Fife ...	89·5±·15	3·28±·11	69·4±·11	2·46±·08	29690± 79	1709± 56
Glasgow (Gartloch)	89·9±·14	3·45±·10	69·5±·10	2·52±·07	29403± 67	1685± 47
„ (Lenzie)	90·5±·13	3·72±·09	70·0±·09	2·68±·07	29061± 63	1776± 44
Govan ...	90·1±·16	3·76±·11	69·4±·11	2·71±·08	29534± 74	1785± 52
Haddington ...	90·6±·38	4·60±·27	70·4±·28	3·42±·20	29546±143	1735±101
Inverness ...	88·7±·17	4·32±·12	69·2±·13	3·31±·09	29974± 66	1656± 47
Lanark ...	91·4±·13	3·75±·09	70·5±·09	2·72±·07	29728± 58	1679± 41
Midlothian ...	92·6±·24	4·07±·17	71·9±·17	2·81±·12	29311±105	1767± 74
Perth ...	91·9±·22	4·32±·16	71·5±·17	3·26±·12	29697± 91	1753± 65
Roxburgh ...	91·8±·24	4·15±·17	71·1±·18	3·09±·13	29514±101	1737± 71
Stirling ...	92·3±·16	4·19±·11	71·3±·12	3·11±·08	29498± 70	1808± 49
Greenock ...	88·7±·23	3·73±·16	68·5±·16	2·64±·12	29567±116	1871± 82
Paisley ...	90·9±·22	3·11±·16	69·8±·18	2·51±·13	29712±120	1703± 85
General Population	90·3±·04	3·94±·03	70·0±·03	2·94±·02	29637± 18	1765± 13

TABLE XXII.

$\frac{H}{B}$ INDEX, $\frac{H}{L}$ INDEX, AND L.B. PRODUCT.—INDIVIDUAL ASYLUMS.—*Females.*

Asylums	$\frac{H}{B}$ Index		$\frac{H}{L}$ Index		L.B. Product mm.^{2}=1 unit	
	Mean	S. D.	Mean	S. D.	Mean	S. D.
Aberdeen ...	90·0±·17	4·42±·12	70·7±·14	3·49±·10	27118± 63	1610±45
Dumfries ...	88·8±·19	3·33±·13	69·1±·14	2·53±·10	27220± 74	1312±52
Dundee ...	89·6±·17	3·56±·12	69·9±·13	2·72±·09	27012± 75	1569±53
Edinburgh ...	92 5±·19	4·03±·13	72·1±·14	2·96±·10	26755± 71	1511±50
Montrose ...	90·0±·25	4·62±·18	71·2±·19	3·47±·14	27269± 90	1635±63
Argyll ...	89·2±·16	3·27±·11	68·8±·12	2·54±·09	27578± 71	1474±50
Ayr ...	89·0±·15	3·51±·11	68·9±·11	2·50±·08	27355± 69	1606±49
Banff ...	88·4±·29	3·38±·20	70·4±·23	2·73±·17	27329±109	1274±77
Elgin ...	88·2±·27	3·77±·19	69·5±·21	2·94±·15	26960±108	1510±76
Fife ...	89·0±·17	3·68±·12	69·4±·13	2·74±·09	27287± 73	1506±52
Glasgow (Gartloch)	89·6±·19	3·60±·13	69·4±·15	2·77±·10	26699± 77	1466±55
„ (Lenzie)	90·6±·14	3·44±·10	70·2±·11	2·65±·08	26960± 55	1378±39
Govan ...	91·0±·16	3·28±·11	70·8±·12	2·53±·09	26871± 70	1425±50
Haddington ...	93·1±·31	3·97±·22	72·1±·23	2·94±·16	26997±122	1541±86
Inverness ...	87·2±·17	3·87±·12	68·4±·13	3·07±·09	27475± 62	1447±44
Lanark ...	90·8±·14	3·80±·10	70·5±·10	2·88±·07	27156± 54	1514±38
Midlothian ...	92·6±·24	4·23±·17	72·0±·19	3·29±·13	26800± 90	1581±64
Perth ...	91·6±·23	3·46±·16	71·5±·17	2·62±·12	27192±102	1556±72
Roxburgh ...	92·5±·25	4·25±·18	72·1±·18	3·16±·13	26984± 86	1478±61
Stirling ...	92·3±·17	4·06±·12	71·7±·13	3·08±·09	27036± 64	1491±45
Greenock ...	89·3±·24	3·55±·17	69·7±·17	2·54±·12	26767± 98	1449±69
Paisley ...	91·2±·26	3·70±·18	71·1±·20	2·89±·14	27295±108	1548±77
General Population	90·2±·04	3·96±·03	70·3±·03	3·02±·02	27108± 17	1537±12

TABLE XXIII.—HAIR AND EYE TABLE.—ASYLUM PERCENTAGES.—*Males.*

Asylums	HAIR				EYES		
	Red	Fair	Medium	Dark	Light	Medium	Dark
Aberdeen	3·42	6·84	33·33	56·41	27·35	51·28	21·37
Dumfries	·00	13·27	83·19	3·54	63·72	24·78	11·50
Dundee	·73	5·84	78·83	14·60	61·31	29·20	9·49
Edinburgh	2·21	9·94	52·49	35·36	51·93	19·34	28·73
Montrose	2·00	29·20	30·00	38·80	31·20	36·40	32·40
Argyll	1·05	·00	90·53	8·42	46·32	35·26	18·42
Ayr	·86	3·86	76·40	18·88	51·50	32·19	16·31
Banff	·00	·00	37·31	62·69	1·49	82·09	16·42
Elgin	4·92	1·64	22·95	70·49	1·64	78·69	19·67
Fife	·47	4·23	80·75	14·55	55·40	27·70	16·90
Glasgow (Gartloch)	·34	5·76	76·61	17·29	49·83	24·41	25·76
„ (Lenzie)	1·08	2·70	67·92	28·30	43·67	23·45	32·88
Govan	1·51	1·51	78·49	18·49	53·58	24·91	21·51
Haddington	·00	4·41	64·71	30·88	72·06	16·18	11·76
Inverness	1·87	3·74	27·10	67·29	11·21	72·43	16·36
Lanark	1·82	4·16	58·96	35·06	55·58	23·64	20·78
Midlothian	2·25	11·28	51·88	34·59	63·91	21·05	15·04
Perth	2·35	13·53	30·59	53·53	21·76	37·65	40·59
Roxburgh	1·45	7·24	65·22	26·09	67·39	20·29	12·32
Stirling	2·61	10·13	40·20	47·06	39·21	33·01	27·78
Greenock	·85	·00	75·42	23·73	52·54	27·97	19·49
Paisley	2·15	·00	78·49	19·36	51·61	30·11	18·28
General Population	1·56	6·49	59·55	32·40	44·94	32·63	22·43

TABLE XXIV.—HAIR AND EYE TABLE.—ASYLUM PERCENTAGES.—*Females.*

Asylums	HAIR				EYES		
	Red	Fair	Medium	Dark	Light	Medium	Dark
Aberdeen	10·19	3·70	20·83	65·28	16·67	51·85	31·48
Dumfries	·69	4·17	74·31	20·83	54·86	24·31	20·83
Dundee	·00	3·52	66·83	29·65	47·24	32·16	20·60
Edinburgh	1·95	2·93	40·97	54·15	49·75	22·93	27·32
Montrose	5·71	2·86	29·52	61·91	13·33	62·86	23·81
Argyll	·00	2·55	78·06	19·39	38·78	35·20	26·02
Ayr	·41	1·63	78·45	19·51	53·66	26·42	19·92
Banff	4·08	2·04	36·74	57·14	4·08	75·51	20·41
Elgin	13·04	4·35	17·39	65·22	4·35	79·71	15·94
Fife	·48	1·91	73·69	23·92	49·76	24·88	25·36
Glasgow (Gartloch)	·62	4·35	73·91	21·12	50·93	26·09	22·98
„ (Lenzie)	·71	1·41	56·89	40·99	37·81	28·97	33·22
Govan	1·08	1·61	66·13	31·18	52·69	19·35	27·96
Haddington	2·70	·00	60·81	36·49	39·19	32·43	28·38
Inverness	8·07	3·76	22·58	65·59	13·98	61·83	24 19
Lanark	0·84	1·68	54·06	43·42	48·74	26·05	25·21
Midlothian	2·11	1·41	38·73	57·75	44·37	32·39	23·24
Perth	2·80	4·67	42·06	50·47	16·82	46·73	36·45
Roxburgh	1·47	1·47	52·94	44·12	50·73	23·53	25·74
Stirling	3·66	6·10	36·58	53·66	23·17	39·43	37·40
Greenock	·00	3·00	70·00	27·00	39·00	32·00	29·00
Paisley	1·09	6·52	69·56	22·83	44·57	34·78	20·65
General Population	2·40	2·89	54·18	40·53	38·97	34·60	26·43

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